Engineering Considerations in Making High-Tension Cable Joints—*Performance Characteristics of Series Transformers and Regular Departments*

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Electrical World

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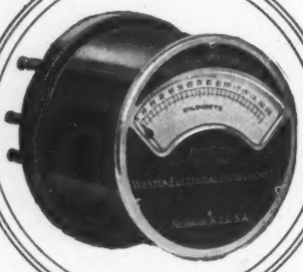

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A Lecture Course on Illumination

THE notable lecture course held in 1910 at Baltimore under the joint auspices of Johns Hopkins University and the Illuminating Engineering Society has always stood as a remarkable achievement on the part of the society, and the co-operation of a leading institution of learning played an important part in shaping opinion toward the ideals of this young but expanding national society. This lecture course, although involving a tuition fee, by the prominence of the lecturers and the extensive laboratory equipment on exhibit, brought together an unlooked-for number of subscribers from throughout the country, sufficient to meet the entire financial outlay for the ambitious scheme, and the general results were so satisfactory as to have exceeded the expectations of those on whom the plans rested. The two published volumes, containing all the lectures, have long been exhausted, and are still in demand. In the meantime, the art and science of illumination has made such progress that these volumes of five years ago no longer cover the field. Dr. Charles P. Steinmetz, president of the Illuminating Engineering Society, as was announced last week, has decided to hold a second series of similar lectures next September, as one of the special features of the tenth anniversary of the founding of the society.

The 1910 lecture course was devoted mainly to illumination as a science. Its aspects as an art or as a part of applied engineering are to be the chief features of the 1916 course. There is thus a distinct opportunity for the society to make of these lectures a remarkable collection of topics dealing with engineering phases of the problem of very great interest and of widespread value to practising illuminating engineers and architects, not to mention the many other fields, such as ophthalmology, physics, chemistry and the like. To make such a plan successful, the lecturers must be drawn from fields of wide experience; and the individuals upon whom will rest the responsibility of setting forth the progress of the art, because of the rapidly changing nature of illumination practice, due to new lamps and methods, must needs be in the most intimate touch with the whole field. Again, the physical arrangements of such an affair assume proportions of much importance.

The whole plan is greatly strengthened at the outset by the enthusiastic support of the provost of the University of Pennsylvania and a strong committee of the university staff. The society has two capable committees, one of administration and the other on the choice of subjects and lecturers. While the personnel of the lecturers has not yet been announced, it is safe to assume that it will be composed of the most prominent men in the profession. The Illuminating Engineering Society deserves much credit for its progressive spirit back of this important undertaking, and the University of Pennsylvania is to be commended for its spirit of co-operation. For a second time the efforts to promote the interests of this engineering society are to be aided by the close co-operation of a leading institution of learning. The interest of the increasingly large group of illuminating engineers throughout the country will center upon this forthcoming lecture course as one of unique and far-reaching importance.

Standardizing Out-of-Door Substations

IN an article of this issue a somewhat new outlook on the construction of the out-of-door substations is discussed. The design details refer to a substation erected for service with 33,000-volt and 11,000-volt transmission lines and a 2300-volt distribution system and represent one of the most advanced pieces of recent construction of this sort of which we have given a description. As a rule such stations have been relatively small and designed without reference to a general program, but merely to meet existing conditions. As a result when growth takes place the operating company is usually hampered by this lack of foresight. The station at Easton, Pa., which the author describes is systematically planned with reference to future expansion and in such a way as to result in mechanical simplicity. Many supports are needed, of course, for the line wires and auxiliary apparatus, but they are simply arranged and the same scheme is carried throughout the installation. In general the whole layout is as orderly as will be found in a well-planned in-door substation, with the advantage of having plenty of space available between conductors and complete freedom from the annoying difficulties associated with the entrance of many high-tension conductors into a building.

One difficulty with out-door substations planned on a large scale seems to be that of metering arrangements, the design of which for this kind of service is still somewhat tentative. There are plenty of air-break switches of the horn-gap type successfully employed in out-door substation work, yet there is a good deal of room for experimentation here, and with units as large as those employed in the Easton plant the general employment of oil switches is for the present at least wise. It would be interesting to know the cost per kilowatt of this out-door station as compared with the older type in which everything is elaborately housed in a station building. As between the relative costs of the two arrangements, the voltage and output of the station un-

doubtedly will be found to have a large influence. In case of small substations the advantage is very greatly on the side of the out-door type, a condition which probably is modified as the voltages and rating grow bigger. One interesting question which might be raised is the possibility of a compromise type in which a part of the structure is roofed over without inclosing walls.

Mr. Samuels' article shows admirably the value of systematic design even in so unconventional a thing as an out-door substation. The saving of overhead charges by such construction is a considerable item and progress along this line deserves to be encouraged, since at last engineers are beginning to graduate from the pressed-brick, tile and concrete style of station. By all means let the out-door substation be worked out to its legitimate conclusion, and its limitations, if such there are, be found out by experience. It is too good a thing not to be encouraged, or to be abandoned at the first encounter with apparent difficulties.

New Functions of the Engineer

IN his investigation of the characteristics that go into the making of successful engineers which Prof. C. R. Mann is conducting for the Carnegie Foundation for the Advancement of Teaching, emphasis has been given to a group of factors which influence the advance of the engineer and which are quite apart from technical knowledge. One factor in the engineer's relation to his work which is emphasized by many practising engineers is what may be called the integrating function—organizing ability.

Organizing ability is being demanded more and more from the electrical engineer. He is now participating largely in the directing of human affairs. In the large groups of men employed by operating, manufacturing and construction companies the individuals have to be functioned and co-ordinated to a common end. As these groups grow larger these individual duties become more and more diverse. Moreover, the different groups in the industry are being specialized so that organizing powers are needed to keep their interests bound together. This is a new phase of the engineer's work. Where once his attention was confined to the forces and materials of nature, now it comprises as well the actions and characteristics of human nature. Organizing involves two processes—dividing and recombining—analysis and synthesis. The first process has been successfully carried out by the engineer, not only in his own industry but throughout the whole economic world. Solely as a result of his efforts have men been functioned. By his engines and apparatus has the division of labor been produced. The individual is no longer a Jack-of-all trades; he is a specialist, and as with the human unit so also with the geographical. Each community is a specialist; railroads have allowed districts to concentrate on the industries to which they are best suited. The functioning of men and of groups has made everyone dependent on one another. These tremendous effects on industry were not the engineer's deliberate object in first devising his machines. But having unconsciously carried out the first step in organizing it now behooves him to perform consciously the second step: the functioned units have to be co-ordinated. Having imposed differentiation on industry, the perils as well as the benefits must be realized. So far industrial output has been greatly increased; the danger is in limiting the creative output. The engineer must now confer the process of integration, otherwise creative powers will be stultified. This process means handling human machinery and it involves an observation of men and a knowledge of motives. In this realm new laws apply. Men are not made as duplicate and interchangeable units. Their characteristics vary widely. Formulas are lacking and a study has to be made of individuals.

In his power stations and in his manufacturing plants, the electrical engineer and the electrical superintendent have two sets of mechanisms to deal with—the human and the inanimate. In an apparatus each wire and part has its duty predetermined with an exact knowledge as to how it will operate. Not so in an organization. There the structure is biological and the functions can at best be arranged only proximately. Allowance must be left for the creative powers of the men filling the positions. Their duties cannot be squared off into rigid compartments; elasticity must be given. That men as well as machines and materials demand attention is not a new thought, but that this integrating function of the engineer has a broader meaning should not be overlooked.

The Making of Cable Joints

CENTRAL station engineers have finally learned by experience that the weakest part of a cable is at the joint and that in high-tension work the strains at these points are the most serious things with which the operator has to contend. In the first place, it is not easy to make a joint in a high-tension cable so as not absolutely to weaken the normal insulation. Besides, the electrical stresses which develop at a joint, as they do about any other region of discontinuity in the system, add largely to the fundamental difficulty. Mr. Torchio gives in another column the result of some interesting and valuable experience obtained in the service of the New York Edison Company, in the making of high-tension joints in cables used up to 25,000 volts. Broadly, the jointing of a cable means opening up the ends, uniting the conductors and then, as well as may be, replacing the normal insulation of the cable, which once broken can never again be really made continuous, by suitable insulating additions. The general process has been to use insulating tapes, or sleeves filled with some hard insulating compound, and these have worked well up to moderate voltages. With high pressures such as are here considered, trouble has been frequent. The difficulty found with all paraffine compounds, solid when cold, was that they shrunk in cooling, leaving cavities which became points of extra stress. The heavy insulating compounds if of high melting point do not fill properly into the crevices and are liable to develop cracks leading to ultimate break-down. A suitable in-

sulating material must fill its space wholly without chance of mechanical cracks and be confined enough if moderately fluid not to ooze away from the conductors, thereby leaving a dangerous gap. The final scheme worked out is both ingenious and effective. The details of the operation show many refinements which have been the result of experience, and the oil-filled splices seem to stand up admirably under 24,000 volts for long-continued use when other types of joint had rather too frequently failed. Moreover, a well-made joint of this kind has been able to withstand almost indefinitely in the laboratory a 50,000-volt test, which speaks well for the effectiveness of the methods employed.

Constructive Regulation

IN one of its early cases the California Commission said in effect that the duty of a public service commission was to regulate so that no regulation would be necessary. In going over reports, decisions, orders and opinions of state commissions which now fill a good-sized room, we have searched in vain for a single decision that indicated promise in this direction. Many of the decisions show painstaking effort and a spirit of fairness, some show the cleverness of a "David Harum" horse trade, a few have been bitter and unfair, but all indicate evidence of eleventh-hour haste to get the particular order finished and signed, and the case put upon the shelf, or into the annual report as a final finished product. No effort has been made anywhere to lay down principles, or to establish theories which would encourage the utilities themselves to push ahead and make rate and other adjustments on their own initiative, sure of the fact that such enterprise will be considered and recorded by the commission.

It is safe to say that most of the commissions consider that their rate-making is based upon valuations, thereby adopting the cumbersome and on the whole stupid expedient which the fourteenth amendment forces upon the helpless federal courts. But the fact is that what the commissions actually do is to hope or guess that at 10 per cent reduction in operating revenue spread out in rate reductions will not seriously affect the company. Such methods while not scientific may be harmless. But lean years or some striking increase in lamp efficiency may turn this kind of guessing on the part of commissions into dangerous meddling, and it is time to put into commission rate-making some serious constructive thought and the opportunity for active co-operation on the part of the public utility companies.

Take the following table as an illustration of how illogical our present method of regulating upon complaint has become:

	Value of Plant	Corporate Income	Fair Return, Per cent	Return Allowed	Rate Reduction
First year..	$100,000	$10,000	8	$8,000	$2,000
Second year.	100,000	10,000	8	9,000	1,000
Third year..	100,000	10,000	9	9,500	500

Let us assume that in a commission rate case a rate-making value of $100,000 is found, that 8 per cent is decided upon as a fair return and that the commission finds an income for corporate purposes of $10,000—of course rates would be ordered reduced by $2,000. But suppose the company was energetic and by increasing its efficiency reduced its operating expenses and broadened its business so that at the end of the next year its income for corporate purposes is again $10,000—assigning the same investment to simplify the problem. A fair commission would say, we are sure—although none has done so yet—that at the end of such a successful year, the company deserved a higher return and would allow 9 per cent, dividing the results of such enterprise between the consumers and the company and making a new reduction in rates of $1,000. Assume that this was repeated the third year, a fair commission might even allow 9½ per cent return and give the consumers an additional $500 rate reduction. This would be fair to all and would encourage the company to a maximum effort until a stable rate were reached. This is in reality the effect of such profit-sharing plans as the Boston sliding scale gas rate. Now, if we assume that the company itself had made the first and second reduction as voluntary reductions and the commissions were regulating for the first time in the third year, under the present principles adopted by the commissions, no credit would be given to the company for its own reductions, and a $2,000 cut in the rates would be made. Whereas had the company refrained from making voluntary cuts and not been efficient and enterprising, the commission cut in regulating would have taken only the first step as shown above and left rates higher than when the complaint was made in the third year.

It is evident that commission regulation carried out as in the past does not foster the voluntary reduction of rates by the public utility company. The companies are in the position of waiting to see what happens before taking the initiative. Unless this broad condition is remedied by constructive regulation the public will not receive the advantage of advances in the art nor the public utility the new capital necessary for improvements and extensions and a just return for initiative and enterprise in management.

The Coming Issues

NEXT week's ELECTRICAL WORLD—the fourth issue for April—will be the commercial number of the month. A leading article on the interesting development of the electric-range load by the central stations of the far West will present the observations on electric-cooking rates and selling plans made by a staff member during visits the first part of this month to the principal Pacific Coast Cities—from the Mexican border to the Canadian line. Timely sales hints on electrical-appliance merchandising will offer suggestions for spring business to the dealer and central-station man, and there will be articles of direct interest and usefulness to the electrical contractor, the jobber, and the manufacturer, besides the usual departments for engineering readers. In the issue of the following week some interesting aspects of water powers will be discussed and an illustrated article on a school for central-station employees will also be given. The May 6 issue will be the public-relations number of that month.

Chronicle of Events of the Industry and of Important Movements in the Field

NEWS OF THE WEEK

Reports of Conventions and Meetings of Electrical Associations and Societies

"Wire-Your-Home Month" Closes

Results From Various Cities for Early Weeks of Campaign Indicate Success of Movement

"Wire-Your-Home Month," the national house-wiring campaign inaugurated by the Society for Electrical Development, which started on March 15, closed to-day. As has been stated before, the demand for co-operative material for advertising and educative purposes has been enormous and has in a number of instances exceeded what at the beginning was thought to be a very liberal supply.

Not only has the Society for Electrical Development, the sponsor for the movement, been swamped with requests for booklets and other material, but the National Electric Light Association, which has been co-operating with the society, and has furnished in the neighborhood of 150,000 of its house-wiring booklets, was obliged to refuse further orders. The manufacturers, particularly the electric lamp manufacturers, have made every effort to supply all requests for advertising material, and it is stated they have found the present compaign to have required more of this advertising matter than any previous campaign.

One of the brightest features of the movement probably is the co-operation which is taking place in almost every community where the campaign has been undertaken between the local contractor and the central station. Enthusiastic comments on this score are being received from every corner of the country and as a result of this co-operation it is anticipated that the final figures of the month if compiled will be found to far outnumber even the most enthusiastic expectations of those responsible for the movement.

While the campaign closes to-day, results for some of the early weeks have been received and would serve as an indication of the further success of the campaign.

Up to the first of April, which was practically the first half of the campaign, 150 homes were wired in Springfield, Mo. The first two weeks of the campaign in Stockton, Cal., resulted in securing forty-seven contracts through the combined efforts of the local central station and contractors. It has been estimated that more than 100 contracts will have been secured here before the close of the campaign.

During the week ended March 25, the campaign in Louisville, which is conducted by the local contractors and the Louisville Gas & Electric Company in co-operation, broke all records for securing house-wiring contracts in that city. The city's building department issued a total of 162 wiring permits during the week. Besides what the contractors signed up, the commercial department of the lighting company in the next week contracted for wiring 107 already-built houses, which is more than this company ever before signed up in this class of business in any one week.

The Public Service Electric Company, which supplies electric light and power service throughout the State of New Jersey, reported that during the first two weeks of the campaign some 300 contracts had been secured. This, it is understood, is many times greater than the average.

During the last week in April the Minneapolis General Electric Company took orders for wiring forty-five already-built houses. In Ottumwa, Iowa, the first two weeks of the campaign resulted in securing thirty-two contracts through the combined efforts of the local wiring contractors and the company. It is believed that when the month is over all previous wiring records for this community will have been broken.

The United Electric Light & Power Company, which supplies the upper part of New York City, reported that while the present contracts were merely an average number, a much greater number of contracts were about to be signed and that the indications are that the effects of the month would be very beneficial. In this connection it was pointed out that the company was probably acting under a handicap since the lowest wiring contract it could secure would be in the neighborhood of $200. For that reason the campaign of "Wire-Your-Home Month" would not produce the same startling effects in that territory that it would in other places where the contract meant the wiring of but a few rooms.

Forty-eight contracts for wiring already-built houses were secured during the first week of the campaign in Little Rock, Ark. In Brooklyn, N. Y., more than 200 contracts were secured in the first three weeks of the movement. The prices in Brooklyn during the month were reduced 15 per cent.

The Harrisburg Company and contractors set out to secure 250 contracts during "Wire-Your-Home Month" and on Wednesday of this week reports from the Harrisburg Light & Power Company stated that in all probabilities the actual number would be much greater than the bogie set.

Valuation Conference of the N. E. L. A.

A conference on valuation brought together representatives of Class A membership of the National Electric Light Association at the Engineering Societies Building, New York City, on April 10 and 11. The conference was called by President E. W. Lloyd, following out a plan suggested in the meeting of Feb. 16 and 17 of the public policy committee.

Expressions of opinion were sought from member companies concerning the desirability of establishing more uniformity of method in making inventories and appraisals and in getting a consensus of opinion within the industry on the possibilty of standardizing valuation terminology. Discussion developed on the following subjects: "Desirability of Uniformity of Methods and Definition of Terms in Valuation Matters," "Actual Cost Versus Estimated Reproduction Cost in Determination of Fair Value," "Differing Methods of Taking Inventories Depending on Use," "Continuous Inventories—Shall They Be Maintained, and If So, How?" "Differing Methods of Appraising Inventories—How and to What Extent Shall Overheads Be Included in Unit Prices?" "Depreciation," and "Going Value as an Element of Fair Value."

It was emphasized in the conference that much confusion exists in the minds of the public utilities, the valuation experts and the commissions as to the terms to be used in valuation proceedings and the general methods of arriving at the physical valuation of a plant. It was the sense of the meeting that the association

appoint a committee which would take up the question of terminology and co-operation with other public utility associations to bring about a more uniform understanding of the problems involved and to arrive at a standard terminology which would be accepted as a basis for valuation discussion in all cases before commissions and courts.

Pacific Gas Stock Dividend Refused

California Railroad Commission Declines to Permit Common Stock Issue to Refund Sinking Fund Payments

The California Railroad Commission has refused authority to the Pacific Gas & Electric Company to issue $1,021,100 par value of its common stock as a stock dividend of 3 per cent on its common stock to refund the sinking fund payments made for part of 1915 and all of 1916.

In denying the application the commission advised the company that unless it adopts a policy of conserving its revenues and assets the commission will inaugurate an investigation of its affairs. It calls attention to the fact that the company in marketing its new 6 per cent preferred stock called special attention to the fact that the issue of this stock was approved by the commission and says, "This company should not adopt a policy that cannot fail to impair the position of these investors."

In connection with an appraisal of the property filed by the company, the commission says in its decision that, while it disclaims any attempt at ultimate finding of values, it holds that on the company's own showing the appraisal would not exceed $79,623,073 against the company's claim of $98,837,490, without allowance for franchises and water rights and without deduction for depreciation. The company is admonished to invest in plant a reasonable part of its net earnings until such time as its assets bear a better relationship to capitalization.

Citing the disparity between the assets of the company and its outstanding bonds and preferred stock as one of the reasons for denying the company the right to issue more common stock at this time, the commission pointed out several changes which it said should be effected in the accounting system. Among them it advised taking the sinking funds out of the surplus account and making better provision for depreciation. In the absence of an agreement on the part of the company to make these changes, it is recommended that the commission take immediate steps to compel the company to introduce a proper depreciation reserve out of its income or surplus.

In referring to the danger of impairing the position of those who have invested in the company's preferred stock, the ruling goes on to say that the condition "is emphasized by the evidence and the practical admission of the company that its depreciation reserves have been inadequate. At the time when it is clear that revenues should be conserved against this depreciation and to build up assets it is proposed to distribute these revenues to the holders of the common stock."

Executive Committee of Commercial Section N. E. L. A. Meets in Chicago

Contrary to its usual practice of holding regular meetings in New York the executive committee of the commercial section of the National Electric Light Association met in Chicago on Saturday, April 8, so that the committee could view convention arrangements at close range. Most of the forenoon session was given over to discussion of committee reports, the final assignment of report work for the convention and other convention business.

At the afternoon session E. W. Lloyd, president of the National Electric Light Association, spoke on convention arrangements. The feature of the afternoon session was a talk on lighting by W. A. Durgin of the Commonwealth Edison Company. Among other things the speaker intimated that even people in the electrical business do not always know what does constitute good lighting. The talk was non-technical in character, and with the aid of apparatus for demonstrating purposes.

N. E. L. A. CONVENTION HEADQUARTERS IN CHICAGO

Mr. Durgin showed the committee members that, notwithstanding the rapid strides made in lighting within the past few years, there is still abundant opportunity for educational and sales work in this field.

Monument to Government Inefficiency

Erection of $5,000,000 Steam Station at Tonawanda Necessary Because No More Niagara Power is Available

Charles R. Huntley, president of the Buffalo (N. Y.) General Electric Company, told the Public Service Commission at Albany on April 4 that his company had already started work on the huge steam plant in the town of Tonawanda, which the company will have to erect because it can obtain no more Niagara power for its growing business. Four hundred men are already employed in laying foundations and other preliminary work in which the company has already expended some $260,000. Within the next twelve months, Mr. Huntley said, the company will expend on account of this plant nearly $5,000,000. The company has applied to the commission for approval of an issue of $3,625,000 securities with which to meet these expenditures in part.

Mr. Huntley told the commission that the steel and boilers and engines for the new plant had already been contracted for. He said that it was fortunate that this had been done, as prices for these items had risen so in the last few months that he had been offered a bonus of $80,000 for his contract for engines and boilers alone. The steel, which he had purchased around $74 a ton, was now selling at from $88 to $92, with no assurances that it could be delivered at any price.

The commission heard the explanation of the various cost items and reserved decision on the security issue. Judge Kenefick, for the Buffalo General Electric Com-

pany, told the commission he would institute another proceeding for the approval by the commission of the franchise for the new plant secured last month from the Town Board of Tonawanda.

Transportation Arrangements for N. E. L. A. Convention

The committee on transportation to the annual convention in Chicago during the week of May 22 of the National Electric Light Association, of which G. A. Freeman of the Commonwealth Edison Company of Chicago is chairman, has laid out a schedule for special trains as given below.

"Red special:" This train will be under the personal direction of Ray D. Lillibridge, 111 Broadway, New York City, and will leave New York City (Grand Central Terminal) on Sunday, May 21, at 12.50 P. M., stopping at Albany, Schenectady, Utica, Syracuse, Rochester, Buffalo and Cleveland, and will arrive at the La Salle street station in Chicago at 11.50 on Monday morning, May 22. Boston cars connecting with this special at Albany will leave Boston at 10 A. M. Sunday, stopping at Worcester, Springfield and Pittsfield, Mass.

"Pink special:" This train will be under the personal direction of J. C. McQuiston, East Pittsburgh, Pa., and will leave New York City (Pennsylvania Terminal) on Sunday, May 21, at 11.06 A. M., stopping at Newark, Elizabeth, Trenton, Philadelphia, Harrisburgh, Altoona and Pittsburgh, and will arrive at the Union Station, Chicago, at 10 A. M., Monday, May 22. Connecting with this train at Harrisburg is a train leaving Washington at 11.45 A. M., Sunday, stopping at Baltimore.

"Purple special:" This train will be under the personal direction of Ell C. Bennett, Syndicate Trust Building, St. Louis, Mo., and will leave the Union Station in St. Louis, via the Chicago & Alton Railroad, at 9 A. M., Monday, May 22, arriving in Chicago at 4.45 P. M.

The committee announces that practically all the various railroad associations throughout the country have authorized reduced fares, but only on round-trip tickets. Requests for detailed information and accommodations should be addressed to the members of the transportation committee in charge of the territory from which one would start. The members of the transportation committee and the points of starting which they cover are as follows:

Ray D. Lillibridge, 111 Broadway, New York City: State of New York, south of but not including Albany and including Greater New York and New Jersey south to and including Newark. F. H. Gale, General Electric Company, Schenectady, N. Y.: That portion of New York State from and including Albany up to and including Buffalo. C. B. Burleigh, General Electric Company, Boston, Mass.: New England States.

A. H. Manwaring, Philadelphia Electric Company, Philadelphia, Pa.: New Jersey, south of Newark; Pennsylvania, west to and including Altoona and Virginia, Maryland, Delaware, District of Columbia, North Carolina, South Carolina, Georgia, Florida, Alabama, Tennessee, Kentucky, Louisiana, Mississippi and Texas. J. C. McQuiston, Westinghouse Electric & Manufacturing Company, Pittsburgh: Pennsylvania, west of but not including Altoona; that portion of Ohio lying south of and including the main line of the Pennsylvania Railroad and West Virginia.

H. N. Sibbald, National Quality Lamp Division of the General Electric Company, Nela Park, Cleveland, Ohio: Indiana, northwestern part of Pennsylvania and Ohio, north of but not including the main line of the Pittsburgh, Fort Wayne & Chicago Railway (Pennsylvania Lines). A. A. Gray, *Electrical Review & Western Electrician*, 608 South Dearborn Street, Chicago, Ill.: City of Chicago, Michigan and that portion of Illinois north of a line drawn from Burlington, Iowa, through Peoria and Bloomington, Ill., directly east of the state line, Minnesota, that portion of Wisconsin, on and north of line drawn from St. Paul to Green Bay, Wis.

Ell C. Bennett, Syndicate Trust Building, St. Louis, Mo.: City of St. Louis and that portion of Illinois south of Peoria and Bloomington. C. F. Farley, Kansas City Light & Power Company, Kansas City, Mo.: City of Kansas City, Kansas, Oklahoma and Arkansas and Missouri with the exception of the City of St. Louis. A. F. Traver, Denver Gas & Electric Light Company, Denver, Col.: Colorado, New Mexico, Nebraska and Iowa. A. A. Dion, Ottawa Electric Company, Ottawa, Ontario, Canada: Dominion of Canada west to and including Winnipeg.

W. J. Grambs, Puget Sound Traction, Light & Power Company, Seattle, Wash.: Washington, Oregon, Montana, Wyoming, Idaho, North and South Dakota, British Columbia and the Dominion of Canada east to but not including Winnipeg. E. B. Strong, Rialto Building, San Francisco, Cal.: California, north of Bakersfield and Paso Robles and Nevada and Utah. J. H. Pieper, Southern California Edison Company, Los Angeles, Cal.: Arizona, and California south of Bakersfield and Paso Robles.

Power Sales Bureau to Give Convention Dinner

It is expected that 200 men will be present at the dinner in Chicago of the power sales bureau of the Commercial Section of the National Electric Light Association which will be held on the evening of May 23. The program for the evening comprises short talks by power men from various parts of the country, and a number of entertainment features. Commercial men, especially those interested in power and sales engineering work, are being invited to the dinner. Those in charge of the local arrangements are: George H. Jones, Commonwealth Edison Company, chairman; W. T. Dean, General Electric Company; Stephen Gardner, Westinghouse Electric & Manufacturing Company; Sidney Vigo, Middle West Utilities Company; C. W. Pendell, Public Service Company of Northern Illinois; R. H. Hunt, H. M. Byllesby & Company, and William Ott, Commonwealth Edison Company.

New England Hydroelectric Consolidation Approved

The Massachusetts Gas and Electric Light Commission has approved the consolidation of the New England Power Company and the Connecticut River Transmission Company under the former name, together with the issue by the consolidated company of new preferred stock of the par value of $719,000 and of bonds of the face value of $2,500,000, to meet the financial requirements of the merger. In connection with this financing a 3000-kw. hydroelectric development on the Deerfield River at Readsboro, Vt., estimated to cost $405,000 and to operate under a 72-ft. head, will be completed in the near future. The board points out that the merger of the companies, which have been operated by the Chase-Harriman, Baker-Ayling interests of Boston since their beginning, may prove of distinct public advantage; that it should enable the consolidated company to raise additional capital more economically, will simplify public relations and relations to local utilities. None of the existing securities of the two companies merged required when issued the approval of the board. For the purpose of this decision the board has not determined their relation to the assets, and does not hold itself responsible for that relation. "The development of these water powers," states the decision, "was one of great commercial hazard, and it is improbable that the enterprise could have been carried through without the aid of the usual speculative value of common stock to secure the backing of investors. Should rate cases arise, the board when dealing with them will be in possession of

facts which will establish the equities between the holder of the securities and the consumers. The board, however, in the approval of additional securities under this petition, has followed the usual rule that their proceeds shall be devoted to the actual cost of property already installed or to be acquired."

Work of Electric Range Rate Committee in Far West

During the past winter a sub-committee on electric cooking and water heating rates has been preparing a report to be presented to the electric range committee of the Northwest Electric Light & Power Association, and this report, containing a great deal of statistical data, will either be presented to the annual convention of the National Electric Light Association at Chicago or at the fall meeting of the Northwest association.

M. C. Osborn, commercial agent of the Washington Water Power Company of Spokane, Wash., is the member of the electric range committee that had in charge the questions pertaining to rates. He appointed as a sub-committee J. E. Davidson, vice-president and general manager of the Pacific Power & Light Company of Portland; E. A. Wilcox, commercial manager of the Great Western Power Company of San Francisco; R. W. Clark, assistant sales manager of the Puget Sound Traction, Light & Power Company of Seattle, and J. F. Derge, superintendent of lighting and appliance sales of the Utah Power & Light Company of Salt Lake City. Mr. Osborn is acting as chairman of the sub-committee.

Approximately fifty answers to questions were submitted by companies. These cover a wide range of subjects, such as population served, climatic conditions, sources of power, fuel prices, time of peak loads, and other important factors.

The report when completed will go very fully into the question of types of rates for cooking and water heating, types of appliances, actual operating conditions that have been determined for investigations of existing loads, and present earnings from cooking and heating loads.

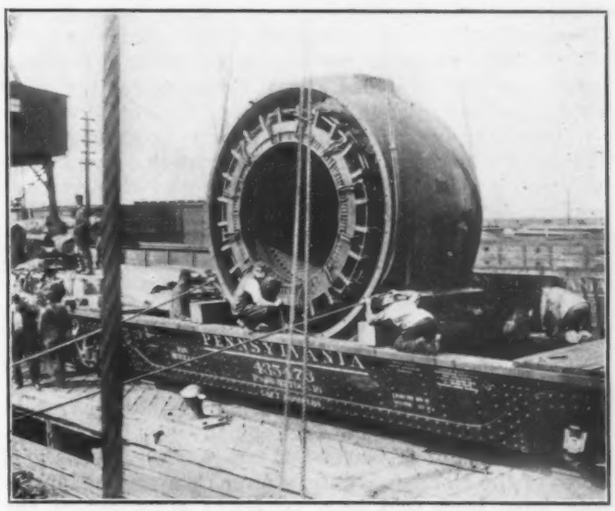
Plans Maturing for Springfield (Mass.) Plant

The United Electric Light Company, Springfield, Mass., has begun the demolition of several of its old buildings at the foot of State Street in preparation for the new steam turbine plant to be erected by the company within the next year. The existing plant will be gradually replaced by the new installation without interruption of service or impairment of efficiency. Plans drawn by the engineering firm of McClintock & Craig, Springfield, provide for a dust-tight boiler house with twelve 700-hp. horizontal Edgemoor water-tube boilers capable of operating continuously at 200 per cent of the builder's rating, with a total capacity of 16,800 b.-hp., and an additional 100 per cent for emergency and peak loads. A 2000-ton bunker will be installed over the boilers and entirely sealed off from the rest of the room. All boilers are to be equipped with seven-retort extension-grate underfeed stokers driven by engines located in the basement. Four fans, each of 60,000 cu. ft. per minute capacity, driven by geared turbines, will be provided in the basement. Feed water will be drawn from the Connecticut River, filtered and elevated to two 5000-hp. open-type heaters, thence being piped to the boiler feed pumps, which will be in a separate room on the boiler-room floor level. Three turbine-driven centrifugal feed pumps of 600-gal. per minute capacity will be installed, with a duplicate pump on each baseplate for elevating the water to the heaters. The working steam pressure will be 225 lb., with 185 deg. Fahr. maximum superheat. The boiler room proper will be 110 ft. long, 84 ft. wide and 80 ft. high. A 20,000-kw. Parsons turbo-generator with Le Blanc jet condenser will be installed and the plant will require four steel stacks, each 10 ft. in inside diameter and 150 ft. high, superimposed on the steelwork of the building. Adjoining the boiler house will be a five-story building 100 ft. long and 50 ft. wide, which will contain various auxiliary apparatus and stock rooms, with sanitary conveniences for employees. The new installation will increase the generating capacity of the system to 43,000 kw. It will cost about $750,000. Walter L. Mulligan is general manager.

Record Breaking Turbine Load for Joplin, Mo.

The largest combination of weight and size ever handled on one freight car by an American railway started last week on a journey to Joplin, Mo., from the Greenville, N. J., yards of the Pennsylvania Railroad Company.

This record-breaking load consisted of the generator



STATOR OF TURBO-GENERATOR BEING PLACED ON FREIGHT CAR

for an 8000-kw. steam turbine and was purchased by Henry L. Doherty & Company from the Brooklyn Edison company. The generator is in one piece, weighs 160,000 lb., and as measured by the railroad from the surface of the rails to the top of the machine stands 15 ft. 7.5 in. in height. Because of this height the railroad was forced to lay out a special detour so that no tunnels or other possible obstacles would be encountered on the run from New York to St. Louis. It is thought St. Louis will be reached in about six weeks, and then another journey must be taken to Joplin, where the generator will be installed at the plant of the Empire District Electric Company.

The Pennsylvania Railroad Company was the only one that would agree to haul this immense burden, as a flat car built in February of this year was discovered to be capable of the task. Up to that time there was no car that could haul this generator as assembled. This is the second stage in the removal, as the piece of machinery was taken by boat from the Brooklyn Edison plant in South Brooklyn to Jersey City.

This turbine transaction is one of a large number now being made in this country as a result of the European war. None of the big electrical machine companies will agree to deliver a turbine in less than one year, and companies urgently in need of power are buying up all the spare machinery available.

General Entertainment Arrangement for N. E. L. A. Convention in Chicago

Entertainment for the delegates to the forthcoming National Electric Light Association convention in Chicago during the week of May 22 is being planned on a somewhat different scale than has prevailed in the past. Delegates are to be given more time to follow their own wishes and not so many afternoons and evenings will be occupied with prearranged entertainment programs. While details have not as yet been entirely worked out, it has been definitely decided that there will be four specific entertainment affairs. The formal reception given by the officers to the delegates will be held on the evening of May 22 in the Gold Room and the Elizabethian Room of the Congress Hotel, followed by dancing. The Bismarck Garden frolic, as the chief entertainment feature of the week will probably be known, will be held on the evening of May 24. The Jovian rejuvenation, which will be conducted on the same evening as the frolic, will begin at 5.45 o'clock at the Bismarck Garden and conclude before the frolic begins. Entertainment at this affair will consist of on-stage performances, balla-hoos and side shows and cabaret. There will also be continuous dancing indoors and outdoors. The entertainment will be somewhat of the same nature as that provided at the Feast of Jupiter given by the Jovian Order in Chicago last October.

Two entertainment features have been arranged for ladies. On Tuesday afternoon, May 23, there will be an automobile ride through Chicago's South Side parks and boulevards to the South Shore Country Club, where luncheon will be served. On Thursday afternoon, May 25, a musicale and tea will be given at the Blackstone Hotel.

Northern States Power Consolidation

Preparatory to the consolidation of the finances of the Northern States Power Company and its subsidiaries an issue of $8,000,000 of ten-year 6 per cent gold notes of the Northern States Power Company of Minnesota have been sold to a syndicate composed of the Guaranty Trust Company of New York, William P. Bonbright & Company, Inc., H. M. Byllesby & Company, Inc., and Spencer Trask & Company. These notes are dated April 1, 1916, and will mature on April 1, 1926. In addition, the company has contracted to sell $18,000,000 of new first and refunding mortgage 5 per cent bonds which will be offered to the public in the near future. The proceeds from the sale of $16,000,000 of these bonds, the $8,000,000 of notes and about $1,500,000 of preferred stock will be applied to the retirement of all the bonds and notes of the system now outstanding, except the Minneapolis General Electric Company bonds, which will be reduced annually through the operation of a sinking fund.

On completion of the consolidation of the finances of the properties, the outstanding capitalization of the system will be substantially as follows:

Minneapolis General Electric Company, first mortgage 5 per cent bonds (closed) $7,632,000; Northern States Power Company, first and refunding mortgage 5 per cent bonds, $18,000,000; Northern States Power Company, ten-year 6 per cent notes, $8,000,000, making a total outstanding funded debt of $33,632,000. The total outstanding stock will amount to $16,627,000 made up of $10,652,000 of 7 per cent cumulative preferred stock and the balance of $5,975,000, common stock.

There will remain unissued of the authorized issue of these notes an amount of $4,000,000, which may be issued only with the approval of the committee representing the noteholders, to provide part of the cost of constructing generating stations or of acquiring operating public utility properties.

The properties of the system comprise plants supplying electric light and power to approximately 100 municipalities in Minnesota, North Dakota, South Dakota, Wisconsin and Illinois, besides serving eleven communities with gas, five with steam heating, three with street railways, and one with telephone service. The total population served is estimated at about 825,000, the principal communities being Minneapolis, St. Paul, Stillwater, Faribault and Mankato, Minn.; Grand Forks, Fargo and Minot, N. D.; Sioux Falls, S. D.; Galena, Ill., and Platteville, Wis.

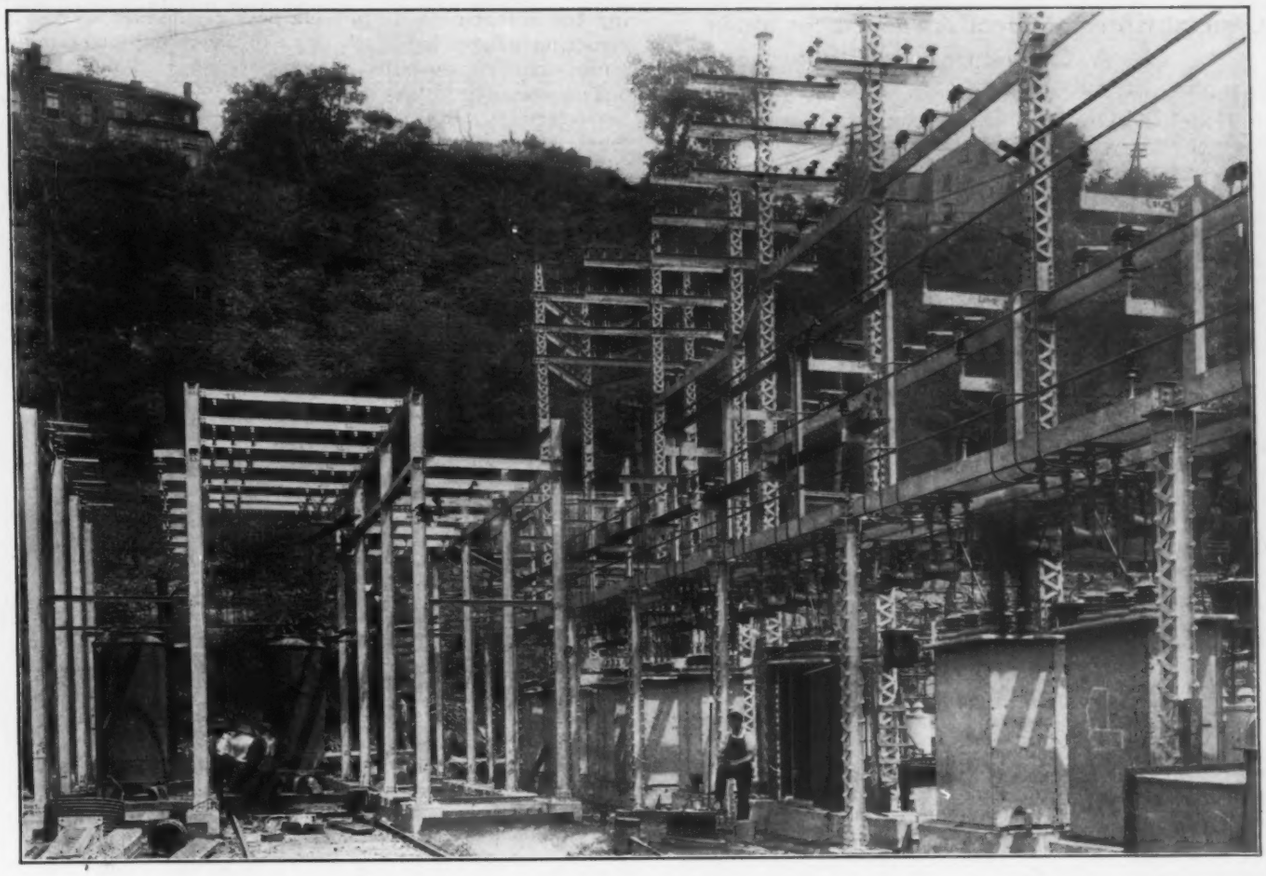
In addition to an installed steam and hydroelectric generating capacity of 115,782 hp., the company owns or controls undeveloped water powers with an estimated capacity of 146,350 hp., which is more than three and one-half times the capacity of the water power sites now developed by the system.

New York Senators Denounce Public Service Commission

Republican and Democratic Senators joined in a sharp attack on the Public Service Commission of the First District, New York, at the Capitol in Albany on April 6 just before passing the bills designed to give 80-cent gas to the residents of certain wards of Brooklyn. Charges of incompetency, and threats to abolish the commission were freely made. It was declared that the dilatory methods resorted to had become a public scandal. The ire of many members was aroused when Senator Thompson read a telegram sent to some Senators by Oscar S. Straus, chairman of the First District Commission, stating that the commission favored the 80-cent gas bill. Senators Wagner and Cullen declared that it was evidence of incompetency, while Senator Brown, the majority leader, held that rather than go over the heads of the public service commissioners in fixing rates the Legislature might better create a tribunal of competent jurisdiction. Senator Foley said that "the trouble with the present public service commissioners is that they suffer from hookworm." Others who attacked the commission as incompetent were Senators Sage of Albany, Walker, Burlingame and Lawson of New York, and Slater of Westchester. The bill, which was nevertheless passed on a vote of 46 to 3, will establish a uniform gas rate of 80 cents throughout Brooklyn.

Commissioner T. H. Whitney issued a statement on April 7 stating why the Public Service Commission had supported the bill for the reduction of the rate for gas in South Brooklyn, although it had the legal power to order such a reduction itself. "The commission holds that the Legislature must make the law more effective if the responsibility of rate-making is to be left to it," he said. "It is not particularly interested in the jurisdiction so phrased as to protect the corporations and not the public. The commission has sent up bills to the Legislature proposing such amendment of the law as it thinks necessary.

"These would prohibit or restrict the court review of rates and service cases by certiorari; would give the commission power to make a new rate effective at any time after the proceedings have been begun; would permit the commission after complaint to declare existing charges excessive and to order their repayment, and would change the penalty provision of the law so that the commission could sue for an amount up to $5,000 a day and not only for $5,000 a day."



Simplifications in Design of Outdoor Stations

Use of Pin-Type Insulators and Rigid Conductors to Strengthen Structures Mechanically and Electrically—Arrangements of Apparatus and Conductors that Simplify Connections—Special Adaptations of Insulators

BY M. M. SAMUELS

OUTDOOR substations, in general, have not shown individual characteristics up to the present time, since they have usually been developed as transmission-line auxiliaries. Instead of representing, as they should, simpler construction and arrangements than are practicable in indoor stations, they comprise in many cases unnecessary complications. In view of this apparent lack of standardization in outdoor substation design the engineering considerations involved in the design of a particular substation will be outlined to show possible simplifications in construction. First of all it may be pointed out that an electrical structure, to be strong electrically and mechanically, should have the least number of insulating supports practicable. This principle has been observed especially in connection with high-tension transmission lines as evidenced by the use of strain-type insulators instead of pin or post-type units. This practice permits employing fewer poles and insulating supports, thereby simplifying the construction and reducing the cost thereof, at the same time minimizing sources of trouble.

Too generous use of strain insulators in station construction, however, should be guarded against since opposite effects are generally produced. Strain insulators are not intended for short spans, since they occupy a relatively large amount of space and leave only a small portion of the span in which to make connections, thus requiring excessive offsets in wires. When used for station wiring they require a large number of crossings, loops and indirect runs, possibly crowding the conductors into several horizontal or vertical planes and sometimes making them inaccessible unless the entire station equipment is de-energized. For lightning arrester connections, especially, it is inadvisable to use strain insulators, chiefly because of the loops and extra insulators necessitated and the higher poles required to secure the proper ground clearance. In the sketches of Fig. 10 differences in construction are shown when suspension and pin-type insulators are used. Because of the objections mentioned it is suggested that rigid busbars and connections be employed in outdoor stations, thus making it possible to reduce the number of insulating supports and eliminate the use of strain insulators. For busbars, copper pipes or bars are preferable.

The features of design mentioned were observed in the layout and construction of the Pennsylvania Utilities Company's outdoor substation at Dock Street, Easton, Pa., and the following brief description together with the accompanying illustrations show how the details of construction were worked out.

The substation is situated alongside the company's steam generating station, the control switchboard being located inside the latter and next to the generator switchboard. While provision has been made as shown in Fig. 6 for ultimately installing four banks of three 1000-kw. 33,000/2300-volt, single-phase transformers

TABLE I—DIMENSIONS AND RATING OF TUBING WITH CONTACT LENGTHS FOR CLAMP JOINTS

Nominal Size of Pipe, Inches	Outside Diameter, Inches	Outside Circumference, Inches	Standard Iron Pipe Size						Extra Heavy Iron Pipe Size					
			Inside Diameter, Inches	Sectional Area of Metal, Square Inches	Copper		Brass or Aluminum		Inside Diameter, Inches	Sectional Area of Metal, Square Inches	Copper		Brass or Aluminum	
					Maximum Carrying Capacity, Amperes	Minimum Length of Contact, Inches	Maximum Carrying Capacity, Amperes	Minimum Length of Contact, Inches			Maximum Carrying Capacity, Amperes	Minimum Length of Contact, Inches	Maximum Carrying Capacity, Amperes	Minimum Length of Contact, Inches
⅛	0.405	1.27	0.281	0.066	66	⅜	43	⅜	0.205	0.095	95	½	62	9/16
¼	0.540	1.70	0.375	0.117	117	½	76	½	0.294	0.161	161	11/16	105	11/16
⅜	0.675	2.13	0.494	0.163	163	9/16	106	9/16	0.421	0.218	218	11/16	142	⅝
½	0.840	2.64	0.625	0.246	246	⅝	160	11/16	0.542	0.323	323	11/16	210	⅝
¾	1.050	3.30	0.822	0.335	335	11/16	218	¾	0.736	0.440	440	11/16	286	11/16
1	1.315	4.12	1.062	0.470	470	¾	305	13/16	0.951	0.648	648	1 1/16	420	1⅛
1¼	1.660	5.21	1.368	0.694	694	⅞	450	15/16	1.272	0.893	893	1 3/16	582	1 3/16
1½	1.900	5.98	1.600	0.824	824	15/16	538	1	1.494	1.082	1082	1¼	710	1¼
2	2.375	7.45	2.062	1.087	1087	1	710	1	1.933	1.495	1495	1⅜	975	1 7/16
2½	2.875	9.01	2.500	1.583	1583	1 3/16	1020	1 3/16	2.315	2.282	2282	1 11/16	1480	1⅝
3	3.500	11.00	3.062	2.257	2257	1⅜	1480	1 7/16	2.892	3.052	3052	1⅞	2090	1 13/16
3½	4.000	12.60	3.500	2.945	2945	1 5/16	1920	1½	3.358	3.710	3710	2	2410	2
4	4.500	14.20	4.000	3.338	3338	1½	2170	1½	3.818	4.455	4455	2⅛	2900	2 1/16
4½	5.000	15.70	4.500	3.730	3730	1½	2430	1 11/16	4.250	5.450	5450	2 5/16	3510	2⅛
5	5.563	17.47	5.062	4.180	4180	1⅝	2710	1 13/16	4.813	6.113	6113	2½	4000	2 7/16
6	6.625	20.81	6.125	5.006	5006	1¾	3270	1 11/16	5.750	8.496	8496	2¾	5500	2¾

Lengths of contact given in above table refer to clamp joint.

and an equal number of 1000-kw. 11,000/2300-volt units with the necessary auxiliary apparatus.

EQUIPMENT IN OUT-DOOR SUBSTATION AT EASTON, PA.

Transformers: Two banks of three single-phase, 500-kw., 33,000/2300-volt transformers and one bank of three single-phase, 750-kw., 11,000/2300-volt units. Three 1000-kva, 11,000/2400-volt and four 1500-kva, 33,000/2400-volt transformers have been ordered.

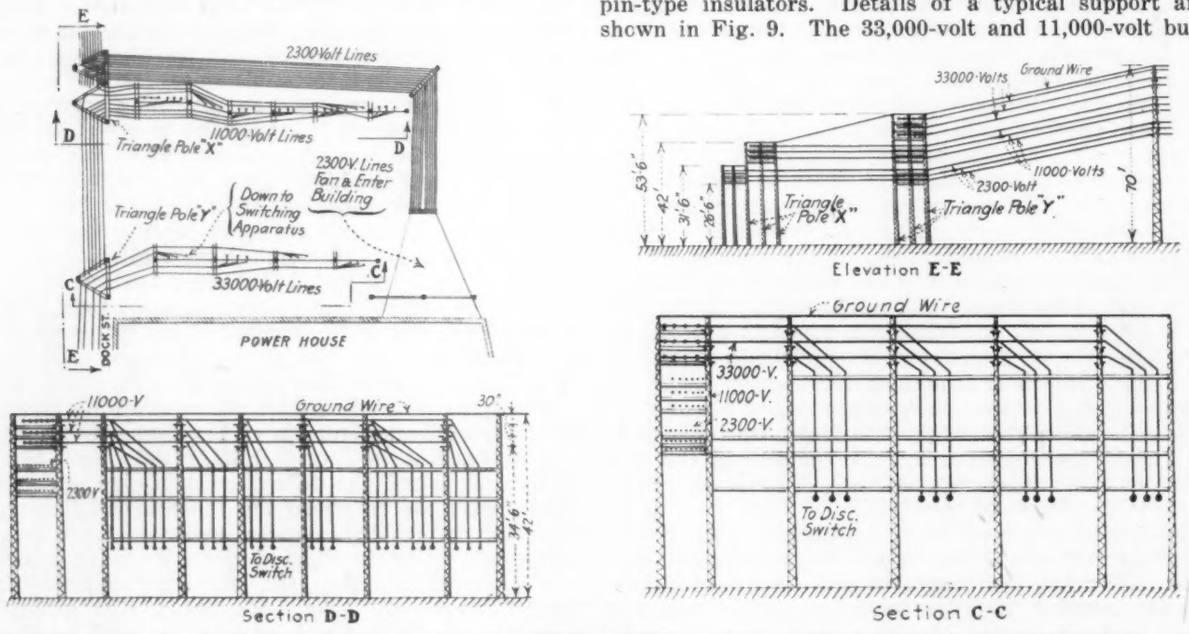
Switches: Two banks of three K-22, single-phase, 33,000-volt, waterproof transformer oil switches and three banks of similar type line switches. One bank of three K-12, single-phase, 11,000-volt transformer switches and six banks of similar line switches.

Lightning Arresters: Three 33,000-volt and six 11,000-volt four-tank electrolytic cells.

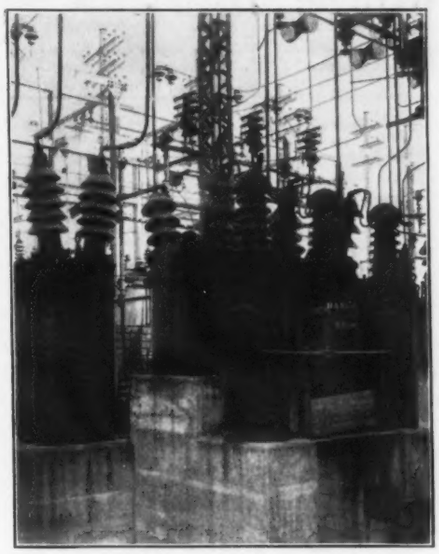
This apparatus was furnished by the General Electric Company.

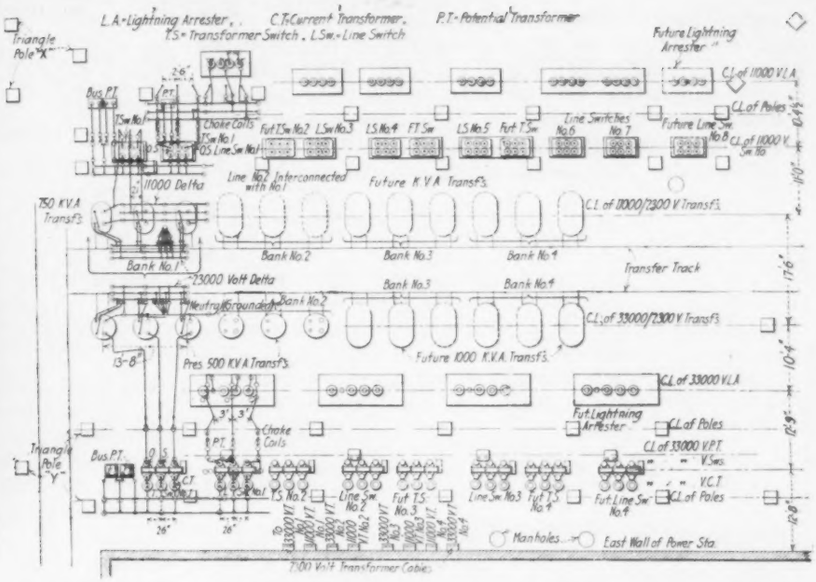
This apparatus is connected with four 33,000-volt and seven 11,000-volt, three-phase circuits, there being in addition several 2300-volt circuits radiating from the generating station and passing through the outdoor substation. As indicated in the accompanying drawings, the 33,000-volt equipment is arranged in three parallel rows on the side nearest the generating station, while the 11,000-volt apparatus is similarly laid out along the far side. Tracks are provided between the two groups so that the transformers, which are mounted on wheel trucks, may be moved into the station for repair or inspection purposes. Each bank of K-22 switches is operated by a single solenoid mechanism mounted on one side of the switch foundation and enclosed by a waterproof case which also houses the operating relay. The 33,000-volt current and voltage transformers are of the outdoor types and are mounted on the foundations of their respective switches. The K-12 switches are not waterproof, so they are inclosed in a sheet-steel housing which also accommodates the 11,000-volt current transformers and switch-operating mechanisms.

Except for the 2300-volt transformer leads and control circuits all of the conductors are carried overhead by a steel structure made up chiefly of latticed steel columns, angle irons and channels. Between the power house and the outdoor 2300-volt busbars the circuits are run through fiber conduit embedded in concrete. The 2300-volt busbars consist of 2-in. x ¼-in. copper bars suspended from steelwork over the transfer track by pin-type insulators. Details of a typical support are shown in Fig. 9. The 33,000-volt and 11,000-volt bus-



FIGS. 1, 2, 3 AND 4—OUTGOING LINES ON SUBSTATION SUPERSTRUCTURE; LINES LEAVING OUTDOOR STRUCTURE (E-E); AND METHODS OF CONNECTING 11,000-VOLT AND 33,000-VOLT LINES WITH EQUIPMENT, OVERHEAD CIRCUITS BEING IN VERTICAL PLANES





FIGS. 5 AND 6—ELEVATED CONCRETE SUPPORTS FOR 33,000-VOLT OIL SWITCHES AND CURRENT AND POTENTIAL TRANSFORMERS; GENERAL ARRANGEMENT OF SUBSTATION APPARATUS

bars are arranged in vertical planes over their respective switches to permit fanning out and connecting with proper equipment.

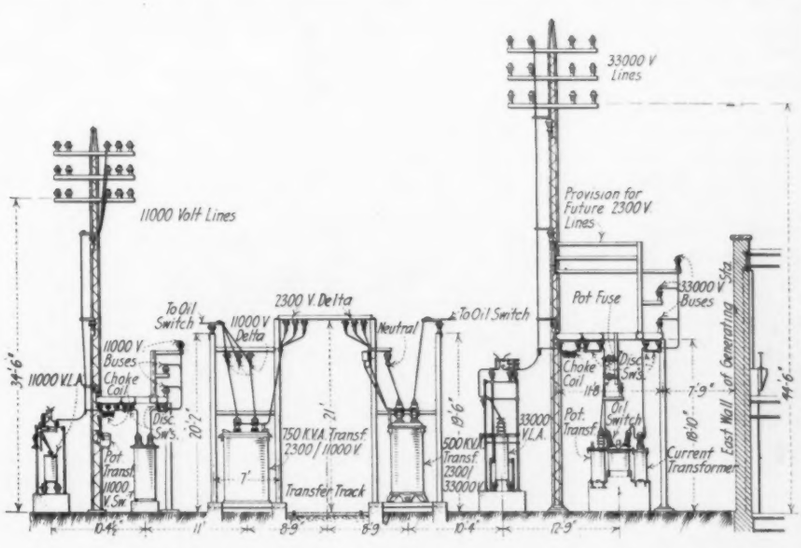
The 11,000-volt connections and the 33,000-volt busbars and connections consist of 0.5-in. copper tube, but the 11,000-volt busbars are made of 1-in. copper tube (iron-pipe sizes). Standard pin-type insulators with General Electric caps are employed to support the busbars, the latter being attached to the caps by 1-in. by $\frac{1}{8}$-in. brass straps. The insulators are mounted on angle-iron cross-arms connected with the general steel framework. Tee connectors were employed to splice branch circuits to the copper tubing, a clamp joint being used on the bus and a slip-and-shrink joint on the branch circuit. Table I gives data for copper tubing and lengths of contact required.

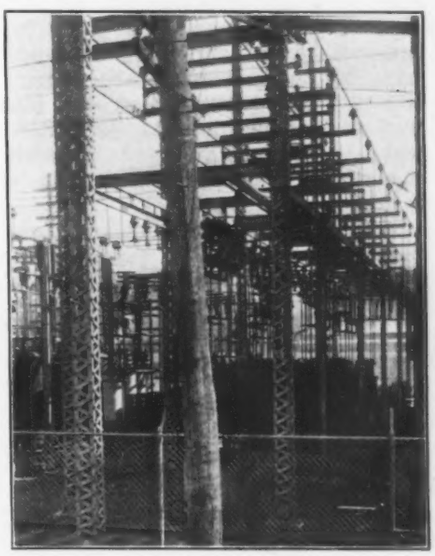
The lightning arrester horn gaps are mounted on pipe framework over their respective tanks. All choke coils and disconnecting switches are suspended from steel bases, being attached thereto by pin-type petticoat insulators. Potential fuses are disconnecting switch type.

In no case were pin-type insulators inclined from the vertical to support vertical or sloping runs of conductors. Instead, special supports were constructed by tying together with steel plates two pin-type insulators as shown in Fig. 11. At right angles to one of the plates connecting the insulators was fastened an angle iron. A U-clamp in one end of the bracket thus formed and another in the tie plate hold the conductor at the proper distance from the pole and cross-beam and permit making right-angle bends in the conductor without depreciating the function of the insulator. The insulators supporting vertical runs are similar but have U-clamps only at the end of the angle-iron bracket.

The 11,000-volt lines lead from their respective switches to a triangle-section pole, indicated as *X* in Fig. 2 (E-E), and from there extend in the direction of the transfer track to another triangle-section pole, *Y*, opposite the 33,000-volt switches. From this point on the 33,000-volt and 11,000-volt circuits, as well as some 2300-volt feeders, are carried on jointly-used poles.

It may be pointed out that all of the outdoor substation apparatus is mounted so that no "live" parts are within reach of persons standing on the ground. Fur-





FIGS. 7 AND 8—CROSS-SECTION OF OUTDOOR SUBSTATION AND VIEW OF 33,000-VOLT BUSBARS SUPPORTED ON STEEL SUPERSTRUCTURE ABOVE APPARATUS SERVED

thermore, such clearances were used between "live" parts and ground that little possibility of interruptions to service by flash-over will be afforded. In the absence of recommendations by any authoritative body on standard clearances the values given in an accompanying table were considered conservative.

Between the generating station switchboard and the

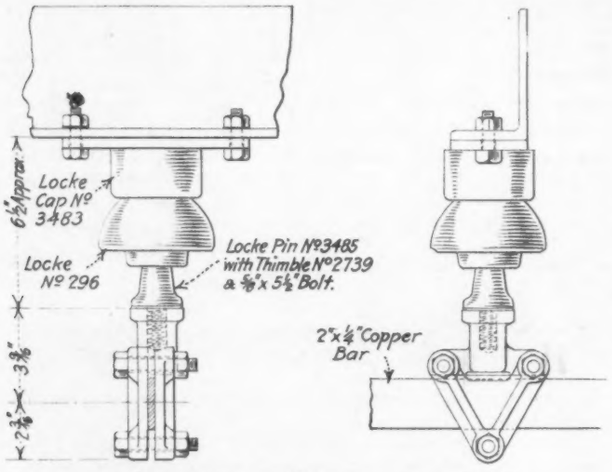


FIG. 9—DETAILS OF 2300-VOLT BUS SUPPORT

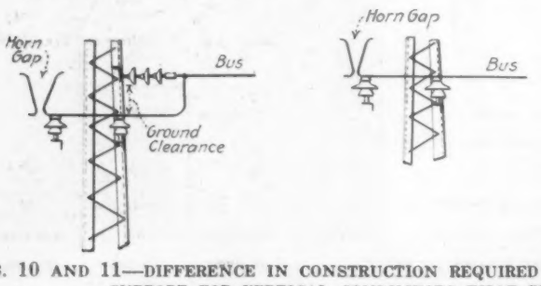
outdoor equipment are provided 12-conductor No. 8 B & S gage, lead-covered underground cables laid in iron pipe. Some of the conductors in each cable are switch-control circuits, others connect the current and potential transformers with the corresponding instruments, and still others are temperature-alarm circuits for the transformers. It may be mentioned that in order to connect the current transformers with the primaries and secondaries of the 2300/33,000-volt, delta-Y joined transformers so they would have the proper phase relation for operating differential relays it was necessary to connect the 2300-volt current transformers inside the transformer delta. For this reason it was necessary to mount them outdoors.

Status of Apparatus Suitable for Outdoor Stations

Since developments in outdoor apparatus so closely affect the design of outdoor stations a few remarks will be made regarding some recent improvements.

Oil Switches. Rapid progress is being made in outdoor switch design along both mechanical and electrical lines. Bushing troubles are gradually being eliminated and methods of arranging solenoid mechanisms and mounting oil switches are being continually improved. The introduction of pipe or angle-iron framework mounting has eliminated the necessity of heavy foundations and made it possible to remove the oil-confining vessels without dismantling the entire switch.

Metering Outfits. Series ammeters or other instruments designed so they may be mounted outdoors on top of oil-switch bushings may be of value for individual



CLEARANCES USED IN EASTON, [PA.] SUBSTATION DESIGN

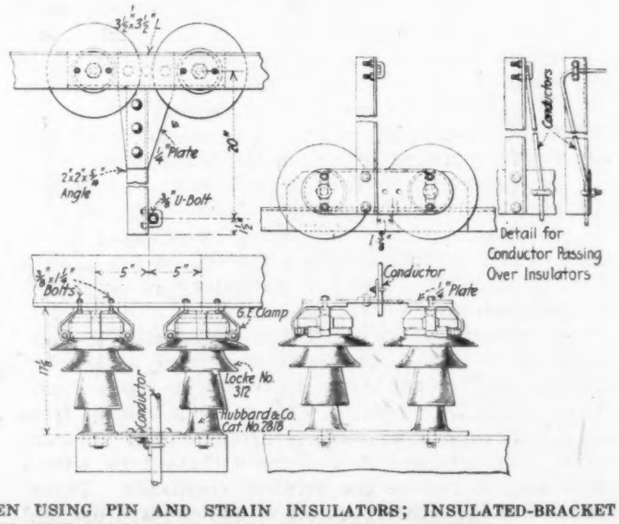
Voltage Not Exceeding	Clearance Between Live Parts, in Inches		Clearance of Live Parts to Ground, in Inches	
	Minimum	Recommended	Minimum	Recommended
7,500	12	15	4	6
15,000	18	21	6	8
27,000	27	30	8	10
35,000	33	36	11	14
47,000	42	46	14	17
70,000	60	66	21	26
88,000	72	80	27	34
100,000	80	90	30	38
140,000	100	120	42	50

customer's stations, but it will probably be found difficult to read them, especially in inclement weather, if mounted where no one can come in accidental contact with them. The "dream" of O. S. Lyford and other prominent engineers of having transformers, oil switches, current and potential transformers and fuses inclosed in the same oil tank may soon become a reality, although most of the elaborate outdoor measuring devices are still in the experimental stage.

Disconnecting Switches. Several types of remote, mechanically-controlled, single-break and double-break disconnecting switches have been developed to eliminate switch hooks and the great amount of space required for operating lever-type switches. Such designs are being tried out on a number of installations.

Airbreak Switches. The high cost of outdoor oil switches has led to the development of many types of airbreak switches equipped with horn gaps and operated by pipe mechanisms. Many of these are yet in the experimental stage, for under ice and snow especially their operation does not appear to be as safe as it should be. Oil switches can, however, be recommended whenever their cost is not prohibitive.

The outdoor substation at Easton, Pa., was designed and constructed under the direct supervision of Louis Saxon formerly chief engineer of the operating company. The property is operated by W. S. Barstow & Company, 50 Pine Street, New York City. This company has about 4000 kva. load connected through outdoor customer's substations operated by its Pennsylvania and New Jersey properties. The operating organization at Easton, Pa., includes: W. D. Ray, vice-president and general manager; R. L. Peterman, general superintendent; C. S. Young, superintendent distribution; W. P. Perry, superintendent substations and C. E. Pihl, chief engineer.



FIGS. 10 AND 11—DIFFERENCE IN CONSTRUCTION REQUIRED WHEN USING PIN AND STRAIN INSULATORS; INSULATED-BRACKET SUPPORT FOR VERTICAL CONDUCTORS THAT PERMITS INSTALLING INSULATORS IN NATURAL POSITION

Operating Characteristics of Current Transformers

Requirements of Current Transformers—Tests to Determine Ratio and Phase Angle—Effects of Different Operating Conditions on Characteristics

BY MARK L. HARNED

THE purpose of the tests described below was to determine the performance characteristics of commercial current transformers and to show the effects of several features of design on these characteristics. It is thought that the results will be of general interest.

When a current transformer is in use its primary is connected directly in series with the main circuit, and the desired instruments or apparatus are placed in series across the secondary, acting as a short-circuited path for the secondary current. Fig. 1 indicates diagrammatically a typical feeder circuit with a current transformer and measuring instruments.

An ideal current transformer should fulfill the following conditions: The ratio of the primary to the secondary current and the phase angle between the primary and secondary currents should be definite and constant from zero current to several times full-load current. Variations in the secondary power-factor should have no effect on the ratio and phase angle. The ratio and

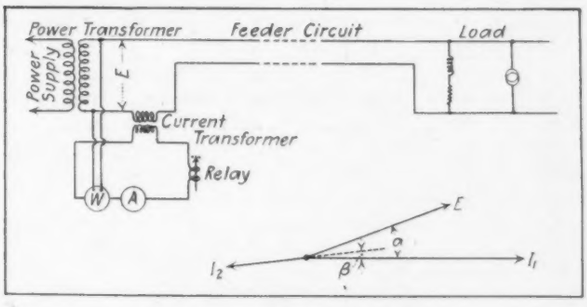


FIG. 1—TYPICAL FEEDER CIRCUIT

phase angle should not be affected by the frequency and wave form of the primary current. Placing different numbers of instruments and relays in the secondary (thus varying the secondary resistance and reactance or the secondary normal full-load watts and power-factor) should have no effect on the ratio and phase angle.

A current transformer which would satisfy completely the above requirements is unattainable. One difficulty is found in the varying permeability of the iron cores for different flux densities and the accompanying lag due to magnetic hysteresis. Also any change of the secondary resistance or reactance will produce a corresponding change in the phase angle.

In the commercial current transformer those factors producing error and variation from the ideal are weighed against each other and a transformer is obtained which is approximately correct over a limited range of current, frequency, secondary power-factor, and normal secondary wattage.

For the purpose of comparing the operating characteristics of typical current transformers, a series of tests was made on the three representative types of current transformers shown in Fig. 2. It is evident from Fig. 2 that these transformers are of widely different designs. Transformer A is of the portable type, with a center hole to receive the primary conductor. Transformer B is for either portable or switchboard use and has a permanently wound primary. Transformer C is of the switchboard type with a permanently wound primary. The large amount of space between the primary and secondary coils in transformer C gives a large leakage path for the secondary flux, thus producing a high reactance and an inherently low power-factor in the secondary circuit. Any change in the external secondary reactance (due to the operation of relays and trip coils or to other cause) therefore has a small effect on the total secondary reactance. Data on the transformers are given in the accompanying table.

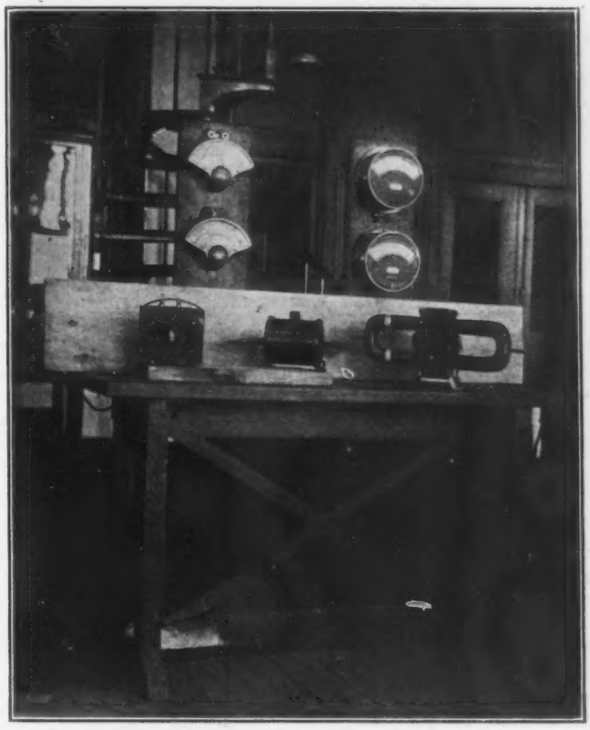


FIG. 2—REPRESENTATIVE TYPES OF CURRENT TRANSFORMERS

A complete test was made on each of the three transformers and readings were taken to determine the ratio and phase angle. Tests were run at four different secondary watt loads each at 5 amp., and each load was taken at four different lagging power-factors. For each load and power-factor readings were taken at six values of the primary current. The loads used were 15 watts, 36 watts, 63 watts and 90 watts. The power-

COMPARATIVE DATA ON THREE TRANSFORMERS

	Transformer A	Transformer B	Transformer C
Primary amperes	150	150	125
Secondary amperes	5	5	5
Ratio	30:1	30:1	25:1
Number of primary turns	1	4	12
Secondary watt rating at 5 amp.	Not given	30	Not given
Frequency, cycles per second	Not given	25–133	25–125
Weight in pounds	15	13	67

factors at which each load was taken were: 0.97 (highest it was possible to obtain), 0.80, 0.60 and 0.40. The primary current was varied from 250 amp. to 25 amp. in six steps. The frequency used was sixty cycles per second.

A diagrammatic arrangement of the apparatus and instruments is shown in Fig. 3.

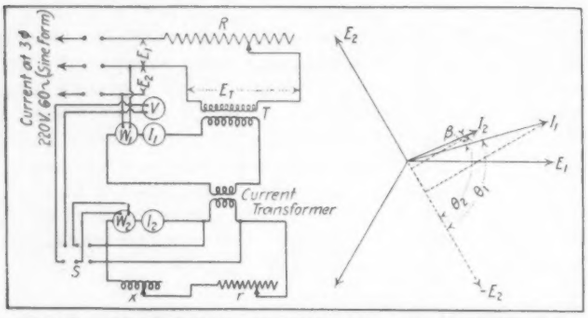


FIG. 3—ARRANGEMENT OF APPARATUS AND INSTRUMENTS

T is a 30-kva., 440/55-volt power transformer used as a current transformer as shown. R is pure resistance for controlling the current. The voltage drop E_T was never over 40 volts, and as the core of T was working at a low flux density, the current had practically a sine form. The reactance x and the resistance r were used to obtain the desired secondary loading. An ammeter I_1 and precision wattmeter W_1 were placed in the primary circuit of the current transformer, and an ammeter I_2 and precision wattmeter W_2 were placed in the secondary circuit. V is a voltmeter and S is a double-pole, double-throw switch. The current was supplied from phase E_1 of the three-phase supply, and both wattmeter voltage coils were normally connected to phase E_2 of the three-phase supply. Switch S was thrown to the right for adjusting the secondary wattage.

The vector diagram at the right of Fig. 3 shows the phase relations of the voltage and the currents in the two wattmeters. By using on the potential coil of the wattmeter the voltage E_2, which is approximately 90

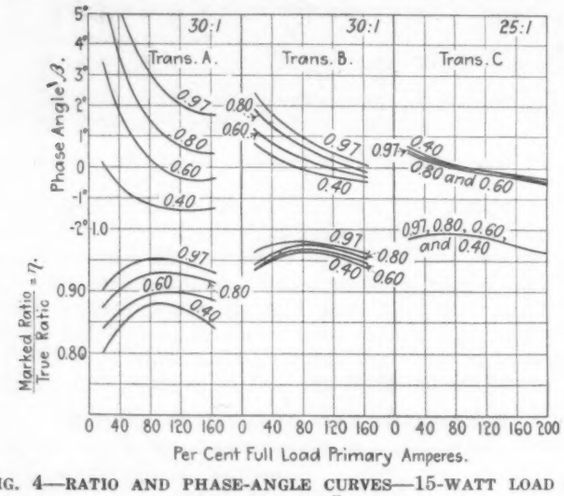


FIG. 4—RATIO AND PHASE-ANGLE CURVES—15-WATT LOAD ON SECONDARY AT 5 AMP.

r = Ratio and phase-angle curves—0.60 ohm. External secondary power factors of 0.97, 0.8, 0.6 and 0.4.

deg. in phase position from I_1 and I_2, a maximum change of wattmeter reading is obtained for any small variation of phase angle β, and thus the accuracy in determining β is greatly increased. With the connections as shown the expression for the phase-angle is

$$\beta = \cos^{-1}\frac{W_2}{E_2 I_2} - \cos^{-1}\frac{W_1}{E_2 I_1}.$$

Objections have been advanced against the use of wattmeters for measuring the phase angle of a current transformer, but the consistent results obtained in the present case indicate that the method is reliable when the wattmeter voltage is approximately 90 deg. out of phase with the wattmeter current. The values for both the ratio and phase angle are subject to the errors of instrument observations. This error, however, is probably within 1 per cent.

The curves shown in Fig. 4 are ratio and phase-angle curves for the three transformers with 15 watts on the secondary at 5 amp. and at the external secondary power-factors 0.97, 0.8, 0.6 and 0.4. The ordinate of the ratio curve is

$$\frac{\text{Marked ratio}}{\text{True ratio}} = \eta.$$

These curves therefore indicate directly the accuracy of the transformer. Figs. 5, 6 and 7 are ratio and phase-angle curves for the various secondary loads and power-factors as indicated.

A number of the peculiarities of current transformers are clearly indicated by the curves. There is only

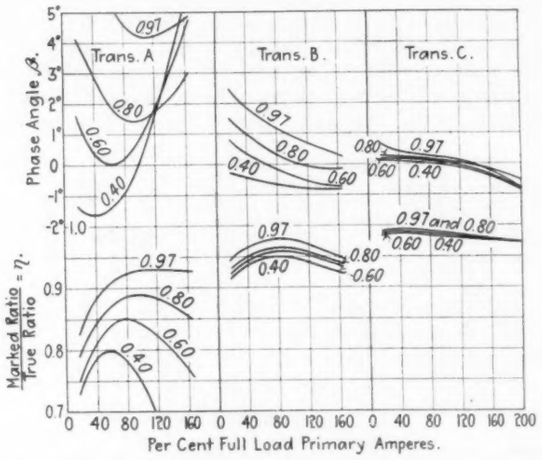


FIG. 5—RATIO AND PHASE-ANGLE CURVES—36-WATT LOAD ON SECONDARY AT 5 AMP.

r = 1.44 ohms. External secondary power factors of 0.97, 0.8, 0.6 and 0.4.

a limited range of primary amperes over which the ratio is constant. A decrease of secondary power-factor at the same watt load is accompanied by a decrease of secondary amperes. Increasing the secondary watt load at the same power-factor also causes a decrease of secondary current. The phase angle decreases for a decrease of secondary power-factor and for a decrease of secondary watt load. The negative phase angle shown by certain of the curves is probably due to the hysteretic lag in the core at high flux densities and to the low secondary power-factor.

The ratio curves have their range of maximum accuracy between 40 per cent and 100 per cent of full load, which includes the average operating range of a current transformer. For high currents the secondary current drops appreciably, and for low amperages the drop is very marked. The general resemblance of the ratio curves to the permeability curve for sheet steel is striking. The curves for transformer A are particularly noticeable in this respect, the maximum point in each case occurring near the same value of the induced voltage and flux density. In general, the permeability of the core has a marked effect on the ratio.

The effect of the number of primary turns is clearly shown by a comparison of the three transformers. Transformer A with a one-turn primary is strongly affected by any change in the secondary circuit. More-

over, with a constant secondary condition (i.e., with a certain secondary resistance and reactance), there is only a short range of current over which the ratio is nearly constant, and the phase angle varies widely. Transformer B with a four-turn primary is affected less by changes in the secondary, and its regulation at a fixed secondary resistance and reactance is much better. Transformer C with a twelve-turn primary is affected very little by changes in the secondary, and its regulation is excellent. This immunity of transformer C to changes in the secondary is not due entirely to the large number of turns. The low inherent power-factor of the secondary due to the large secondary leakage path is an important factor. Any change of power-factor in the external secondary circuit has a less effect on the total secondary power-factor than in the case of transformers A and B.

For measurement of current the best conditions are obtained when the external secondary resistance (or normal full-load secondary watts) is low and the external secondary power-factor is high. By reference to the curves it is seen that the ratios are the most nearly accurate under these conditions: i.e., with an

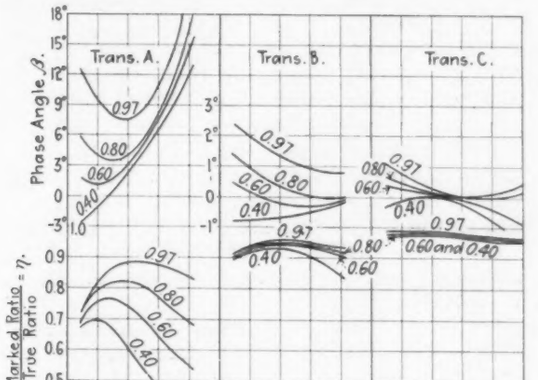


FIG. 6—RATIO AND PHASE-ANGLE CURVES—63-WATT LOAD ON SECONDARY AT 5 AMP.

r = 2.52 ohms. External secondary power factors of 0.97, 0.8, 0.6 and 0.4.

external secondary resistance of 0.6 ohm and a power-factor of 0.97. The maximum accuracy of transformer A is a trifle over 95 per cent, while transformer B reaches an accuracy about 98 per cent and transformer C has an accuracy of 99.5 per cent. With each transformer its maximum accuracy occurs at 80 per cent of full-load primary amperes.

Since practically all alternating-current ammeters are calibrated only from 20 per cent to 100 per cent of the full scale, the most important range of ratio is from 20 per cent to 100 per cent of full-load primary amperes. Within these limits and with conditions of maximum accuracy, the variation in the ratio for the different transformers is as follows: Transformer A, from about 90 per cent to 95 per cent (a range of 5 per cent); transformer B, from about 96 per cent to 98 per cent (a range of 2 per cent), and transformer C, from about 98.5 per cent to 99.5 per cent (a range of 1 per cent). If, when calibrating an ammeter to be used with a current transformer, the mean true ratio is used as the multiplier, instead of the marked ratio, the maximum variation in accuracy from 100 per cent will be reduced to one-half of the above range of variation.

In discussing the suitability of the various transformers for use with wattmeters and watt-hour meters it will be necessary to consider the combined effects of the ratio, the phase angle, and the power-factor of the main circuit in which the primary of the current transformer is connected. The vector diagram in Fig. 1 shows the relations of these various factors. Let

E = voltage of main circuit,
I_1 = current in the main circuit,
α = phase angle between E and I_1,
I_2 = current in the secondary of the transformer,

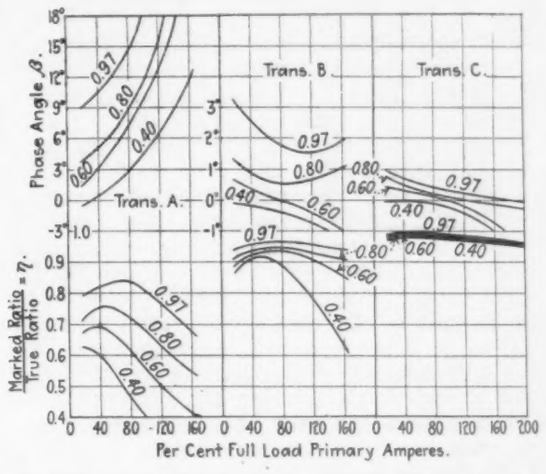


FIG. 7—RATIO AND PHASE-ANGLE CURVES—90-WATT LOAD ON SECONDARY AT 5 AMP.

r = 3.6 ohms. External secondary power factors of 0.97, 0.8, 0.6 and 0.4.

W_t = true power in main circuit = $EI_1 \cos \alpha$,
W_i = indicated power in main circuit,
β = phase angle between I_1 and I_2,
R_s = marked ratio of I_1 to I_2,
R_t = true ratio of I_1 to I_2, that is, $R_t = \dfrac{I_1}{I_2}$.

When the marked ratio is used in the calibration of the wattmeter,

$$\frac{W_i}{W_t} = \frac{R_s I_2 \cos(\alpha - \beta)}{I_1 \cos \alpha} = \eta_i(\cos \beta + \tan \alpha \sin \beta).$$

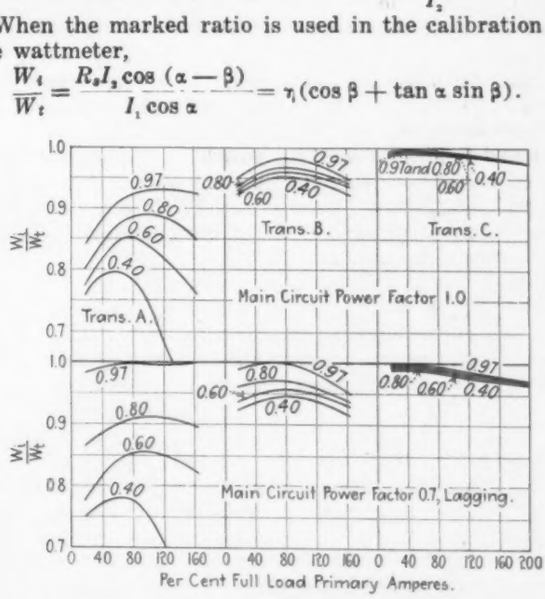


FIG. 8—WATTMETER ACCURACY CURVES—36-WATT LOAD ON SECONDARY AT 5 AMP.

r = 1.44 ohms.

When the power-factor in the main circuit is unity, α is zero, and this ratio becomes

$$\frac{W_i}{W_t} = \eta_i \cos \beta.$$

That is, for unity power-factor the ratio of indicated power to true power varies directly as η_i, and also directly as the cosine of the phase angle. As the cosine of a small angle is very nearly unity, the ratio $\dfrac{W_i}{W_t}$ will

vary practically as η for unity power-factor in the main circuit.

The "wattmeter accuracy curves" in Fig. 8, which are based on the conditions of Fig. 5, are calculated from the above formulas. The upper set is for unity power-factor in the main circuit, and the lower set is for a main circuit lagging power-factor of 0.70. These curves are instructive mainly in showing the effect of changes of the main circuit power-factor on the accuracy of the wattmeter reading when the transformer has an appreciable phase angle. The curves for transformer A show that the maximum accuracy, with unity power-factor in the main circuit and 0.97 power-factor in the external secondary circuit of the transformer, is 93 per cent, with a range of 9 per cent for a variation of 20 per cent to 100 per cent of full-load primary amperes. With a change of the main circuit power-factor from 1 to 0.7 the maximum accuracy is increased to 100 per cent and the range reduced to less than 2 per cent. With a transformer secondary power-factor of 0.4, a decrease of the main circuit power-factor causes a decrease of accuracy instead of an increase. This is because the phase angle is negative.

With a positive phase angle and lagging current in the main circuit, the wattmeter accuracy curves are raised when the main circuit power-factor is lowered; with a negative phase angle, the accuracy curves are lowered for a lowering of the main circuit power-factor. When the main-circuit power-factor is leading, the effects are reversed.

Transformers B and C are affected in the same manner as transformer A, but to different degrees respectively. Although transformer A is very susceptible to changes, there are certain set conditions, as pointed out, under which it would be quite as satisfactory for use with wattmeters as either transformer B or transformer C.

Throughout the foregoing discussion it has been assumed that the wattmeter is calibrated by using the marked ratio as the multiplier. If a mean true ratio is used instead of the marked ratio, the effect will be to shift the accuracy curves upward.

Other apparatus used in the secondaries of current transformers besides ammeters and wattmeters includes power-factor meters, overload relays, trip coils, reverse power relays, voltage regulator compounding coils and other special apparatus.

Power-factor meters work somewhat on the same principle as a wattmeter in that they employ voltage coils and current coils, the indication being obtained by the magnetic action between the two sets of coils. Current transformers furnish current for the current coils, and the voltage coils are connected across the line. The magnitude of the current is not important as long as it is sufficient to operate the instrument. The phase angle of the secondary current with respect to the line current, however, is important, because any change in the phase angle produces a direct and corresponding change in the indication of the instrument. Over the range of load current the phase angle should be close to zero.

Transformer C is uniformly the best of the three transformers in regard to the phase angle. However, under certain conditions of secondary loading, transformer B would be just as satisfactory. Transformer A has also proved to be fairly satisfactory, under certain conditions.

Overload relays and trip coils for operating alarms, opening circuit-breakers, etc., operate on excessive currents only. Most relays and trip coils are designed for a normal current of 5 amp. and are used in the secondaries of current transformers. Relays of the instantaneous type are set to operate at some definite overload on the main circuit, say at 200 per cent of full load. When the relays or trip coils are calibrated by the manufacturer, however, the calibration is extended over a certain range of actual relay current. When such a relay is applied to a circuit through a current transformer it is therefore important that the ratio of the transformer be constant over this range of current. For example, if the ratio falls off at high overloads and the relay is set to operate at 200 per cent of its normal current (or 10 amp.), the relay may not actually operate until the main circuit load is considerably above 200 per cent of full load.

By reference to the curves it is seen that under certain conditions the change in ratio may be quite large. With high secondary loads (watts), or high secondary resistances, and low secondary power-factors, the ratio of transformer A falls off rapidly and would produce a large error. Transformer B is affected to a less extent than transformer A, while transformer C holds its ratio remarkably constant. Thus, if a transformer either of type A or type B is used with an overload relay, the secondary resistance should be kept low and the secondary power-factor high.

The lowering of the power-factor in the secondary, due to the operation of an instantaneous relay, would reduce the secondary current and affect any other instruments that might be in series with the relay. The reduction of current would not affect the relay itself, however, because the reduction of current cannot begin until the relay armature begins to move, and then a very small current will pull the armature up.

With an inverse-time-limit overload relay, however, the initial ratio of relay current to line current may be low, and as the relay armature pulls up, the decreasing power-factor will further decrease the ratio, so that the characteristics and protective properties of the relay may be seriously impaired.

Reverse power relays operate on the principle of the wattmeter. The requirements of a current transformer for a reverse power relay are, therefore, the same as in the case of a wattmeter; hence a transformer which is satisfactory for a wattmeter would be satisfactory for a reverse power relay.

Current-compounding coils on voltage regulators generally surround a common iron core with a voltage coil, and it is desirable that the current in the current coil have a definite phase relation to the voltage or current in the voltage coil. The ratio should also be constant. (These current coils operate on normal currents only.) This service then would require a current transformer with the same characteristics as one for use with a wattmeter.

From the foregoing discussion several important conclusions in regard to current transformers can be drawn:

1. When choosing a current transformer for any purpose the importance of fully realizing the operating characteristics of different types of current transformers and the effects of different conditions of operation on these characteristics cannot be over-emphasized.

2. The greater the number of turns on a current transformer, the better will be its general operating characteristics.

3. A high inherent secondary reactance reduces the effects of any change in the secondary circuit and thus improves the characteristics.

4. An increase of external secondary reactance decreases both the secondary current and the phase angle.

5. An increase of secondary resistance decreases the secondary current but increases the phase angle.

6. If a transformer which has an appreciable phase angle is used with a wattmeter in a circuit which is subject to low power-factors, a large error may be introduced into the reading of the wattmeter.

The Construction of High-Tension Cable Joints

Methods Employed by New York Edison Company for Insuring a Definite Potential Gradient and Eliminating Voids and Other Objectionable Flaws in Cable Joint Insulation

BY PHILIP TORCHIO
Chief Electrical Engineer of the New York Edison Company

IN late years the concentration of power generation has required the operation of underground cables at relatively high transmission voltages. Up to the present time cable splices for these high voltages have usually been made with insulating fibrous tapes or tubes and hard compound fillers, which have been generally satisfactory for pressures up to 13,000 volts. Many troubles have ensued, however, when joints so constructed have been used with extra-high voltages.

The need of improving the methods of making such cable splices was recognized several years ago by the New York Edison Company, and extensive studies and tests with different kinds of joint-filling compounds were conducted in connection with different types of carefully made joints; but all these joints failed to give uniform and satisfactory results. Paraffine compounds were found unsatisfactory, because on cooling they contract, leaving pockets. Heavy gum compounds having high melting points did not flow into the crevices, and, moreover, under short-circuit stress cracks were formed which did not heal and finally caused break-down. Later experiments were conducted with liquid fillers (fluid at low temperatures) such as rosin or mineral oils used in the insulation of cables. The chief difficulty found with liquid fillers is that they may run into the cable and leave voids in the joint. After considerable experimenting, however, this difficulty was completely overcome by a design of joint briefly described as follows:

The cable splice is hand-wrapped with oil-saturated paper tape, insulating oil being brushed all over the surface of each layer. In a similar manner over the three conductors, properly spaced and packed with a saturated filler, is wrapped an outer jacket, which is then pierced at several points so that the oil will freely enter the interior of this jacket. Over the jacket is applied copper gauze, and around it a heavy lamp wick. The object of the metal gauze is to provide a continuous metallic cover around the solid insulation to protect the latter against electrostatic charges, even if some of the oil leaves the joint, and still allow the oil free access through the holes of the gauze. The lamp wick is applied to retain by surface tension the insulating oil in the splice, even if the oil should leave the annular space between the insulation and the lead jacket. The latter is made somewhat larger than usual to hold an extra amount of insulating oil to feed the lamp wick. After the joint is completed it is subjected, by means of a vacuum pump, to a vacuum of about 27 in. to 29 in. and then filled with a liquid compound. To supply any oil absorbed by the joint and the cable connected to it a special pressure cup full of oil is applied and left connected for twenty-four hours, after which time the cup is removed and the hole capped and sealed.

Splices of this type are being used on three 25,000-volt underground-cable transmission lines. Under laboratory test they have withstood without failure 50,000 volts, three-phase, for over 340 hours, when the test was discontinued. Out of more than thirty experi-

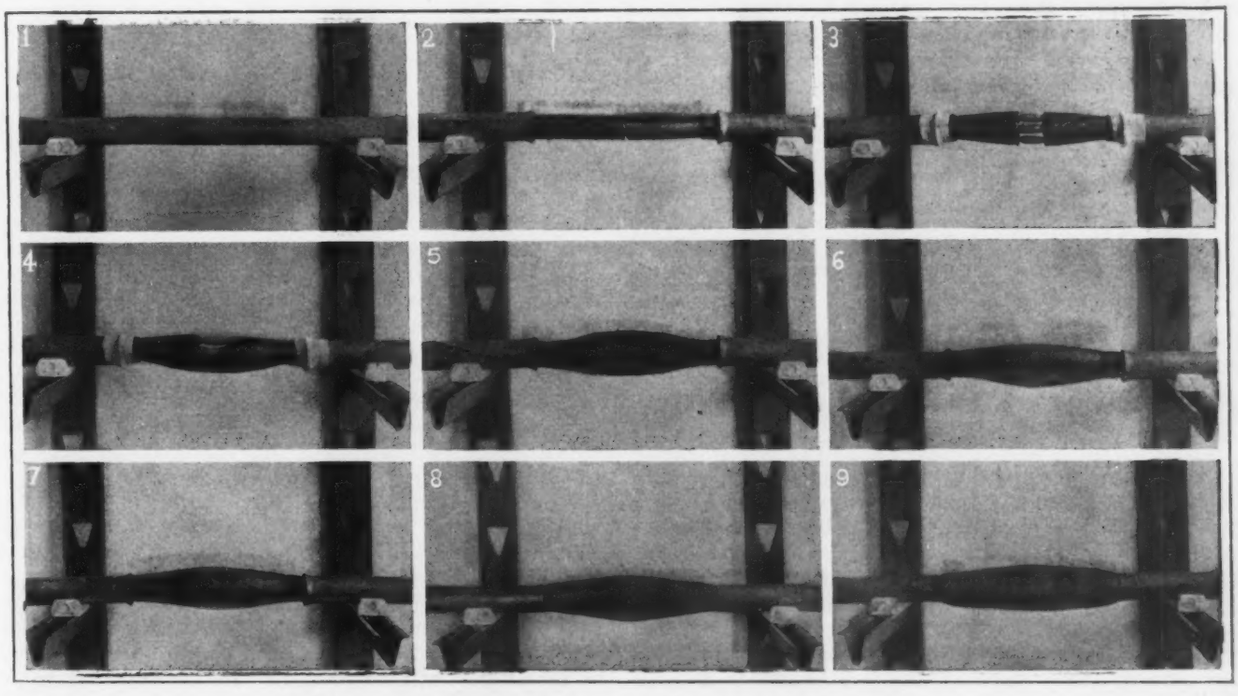


FIG. 1—STEPS IN THE PROCESS OF SPLICING 25,000-VOLT JOINT

1. Cut-ends of cables in position for joining; 2. Lead armor removed from cable ends and belled; 3. Paper belt stripped from insulated conductors, cheesecloth wrapped around belled armor, and connectors soldered to conductors; 4. Insulation on each side of connectors has been tapered and lower conductor wrapped with paper tape; 5. Spaces between conductors filled with compound and impregnated jute rope; 6. Paper-tape belt applied; 7. Holes pierced through compound and belt and passing between conductors; 8. Copper-gauze stocking applied around joint; 9. Gauze wrapped with cotton wick.

mental splices of all types, the oil-filled ones were the only ones which withstood indefinitely the 50,000-volt, three-phase test. Some of these splices were tested with equally satisfactory results, even when drained of all the oil in the annular space between the joint and the lead sleeve. Up to the present time 290 cable splices have been in service for about eight months without a failure supplying energy to a large 24,000-volt, single-phase railway served by the United Electric Light & Power Company. Prior to the development of these joints even the best-made joints of the older types failed as often as once a month on less than 16,000 volts.

The joints referred to were made with three-conductor, 350,000-circ. mil, paper-insulated, lead-covered sector-type cable. The insulation around each conductor is 8.5/32 in. thick, and the insulating belt is 4/32 in. thick, making a total of 17/32 in. between any two conductors and 12.5/32 in. between any conductor and ground. The neutral of the system is grounded.

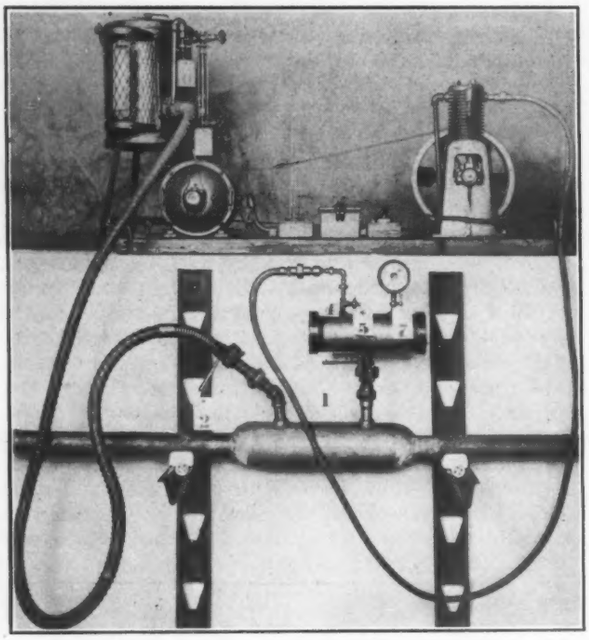


FIG. 2—CONNECTIONS OF APPARATUS FOR CREATING VACUUM IN JOINT AND FILLING WITH COMPOUND

At the upper left-hand corner of the illustration is a reservoir and kerosene furnace for heating compound to 275 deg. Fahr. Attached to the reservoir is a thermometer with a range of 50 deg. to 450 deg. Fahr. and a gage glass for indicating the height of compound in the tank. At the right is a 3-in. by 3.5-in. vacuum pump which is belt-driven by a 90-volt 0.5 hp. motor. Attached to the right-hand end of the cable-joint sleeve is a suction chamber equipped with a vacuum gage. This chamber is connected with the pump by a 0.5-in. flexible spiral-metal hose capable of withstanding more than 29-in. vacuum. The hose between the compound reservoir and the left-hand end of the splice is 1 in. in diameter. Valves Nos. 1, 2 and 3 are Lunkenheimer quick-acting lever-type and valves Nos. 4, 5, 6 and 7 are two-way straight pet cocks.

Method of Preparing Cable for Jointing

Before preparing the cables for splicing they were carefully aligned, as it is very undersirable to bend or make any change in the position of cables after they are soldered. With this done 8.5 in. of the lead sheath was stripped off the ends to be joined, the belt insulation removed except for 1.25 in. next to the lead armor, and 1.125 in. of insulation cut off the end of each conductor at right angles thereto with a special tool provided for the purpose. The ends of the lead armor were then "belled," as this operation cannot be performed so easily after the conductors are soldered. To prevent accumulation of dirt and penetration of moisture, the space between the belled armor and the insulation was packed with insulating compound and wrapped with clean cheesecloth, which was allowed to lap over the armor. Split connectors, 2 in. long, chamfered 0.5 in. on each end to remove sharp edges (which would cause static discharge) were then fitted over the ends of abutting conductors, and soldered. All metal points, such as those formed during soldering, were then removed by filing and rubbing with emery cloth, and the space between conductors was thoroughly cleansed of all emery, copper or solder particles.

Following this operation, but not until the splicer was ready to continue with insulating the joint, the mill insulation on each conductor was penciled or tapered toward the connectors, as shown in one of the accompanying illustrations, to increase the leakage path from each conductor to the outer layers of the mill insulation. Compound was then packed in the recess between each connector and the penciled ends of the corresponding conductor insulation and impregnated jute rove wrapped tightly in this space, each turn being drawn tight so as to force the compound out between the separate turns of the rove. The operation was continued until a straight line was obtained between the highest points of the penciled insulation and the chamfer on the connector.

Before proceeding with insulating the joint, the outer layer of mill insulation on each conductor was removed to insure surfaces free from deposits of moisture and dirt and to secure a more perfect bond for the hand-wrapped insulation which was applied later. This was considered important, as otherwise discharge paths might occur along these surfaces. A liberal coating of compound was then applied to the conductor to be insulated and paper tape, impregnated with the same compound under a 29-in. vacuum, wrapped tightly around each conductor. For convenience in handling, to obviate the necessity of unduly spreading the conductors during the process of insulating, and to minimize the possibility of contamination with moisture and dirt (usually caused by rerolling tape on a job), the paper tape was furnished in small rolls 0.75 in. in diameter. The tape was 0.875 in. wide and 6 mils thick.

Application of Paper-Tape Insulation

Starting on a connector, in applying the tape, the length of each succeeding layer was increased to meet the beveled surface of the rove filler. When the high point of the tapered mill insulation was reached the wrapping was extended out in both directions to within 1 in. of the crotch of the three conductors. Then each succeeding layer was shortened so as to produce a long, even slope extending from the point 1 in. from the crotch to the highest point of the mill insulation taper. At this point the thickness of the hand-applied insulation was made one and a quarter times that of the mill insulation. Each layer of tape received an application of compound before applying the succeeding layer, and each turn was drawn tightly to remove all evidence of air bubbles between layers. It may be pointed out that all materials used in splicing were packed and delivered in units sufficient for only one splice.

After each conductor had been individually wrapped with paper tape as described, the space between conductors was packed with compound and a quantity of impregnated rove fillers were laid parallel with the conductors and pressed into the spaces between them. Before the belt insulation was applied 0.375 in. of the 1.25 in. of mill insulation left at each end of the splice next to the armor was tapered. Then impregnated paper tape 1 in. wide and 6 mils thick was wrapped around the three insulated conductors, first filling the concavities at each end of the splice, then extending the tape over the rest of the joint until a belt one and a quarter times as thick as the jacket mill belt had been applied

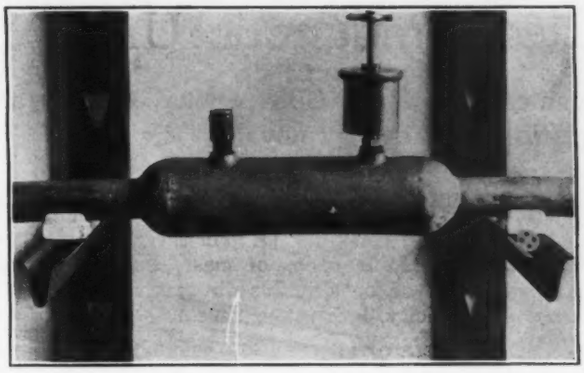


FIG. 3—APPARATUS SUPPLYING COMPOUND TO COMPENSATE FOR ABSORPTION BY CABLE

on an even slope. The same precautions to eliminate voids were observed in applying the belt as in insulating the individual conductors.

When the hand-applied belt was completed it was pierced in six places to permit escape of air and free admission of compound. The holes extended through the joint and between the conductor insulation. After removing the cheesecloth which had been previously bound around the belled ends of the armor the belt was tightly wrapped with a copper-gauze stocking, made of 30-mesh No. 30 wire, long enough to extend under the lead armor 0.5 in. at both ends. This was smoothed out so it would bear evenly on all parts of the splice and soldered in five places along its longitudinal seam exclusive of the ends. The belled armor was then beaten down on the stocking and soldered to it, thus establishing a metal sheath around the joint which has the same potential as the lead armor. This insures a definite distribution of potential over the conductor insulation and belt, independent of the insulating material later placed between the copper stocking and the lead jacket.

Around the copper-gauze stocking was wrapped cotton wick 1.5 in. wide and approximately 3/32 in. thick. One layer was wrapped over the central portion of the splice, and toward the ends layer on layer was built up to form a reservoir of compound which would supply the single layer by capillary action. Thus the splice is kept saturated even if some of the compound from the splice is absorbed during service by the cable. The lead sleeve was applied in the usual way, but pipe taps were provided at each end for connecting apparatus used in exhausting air from the joint and filling it with compound.

VACUUM PUMP FOR FILLING JOINT WITH COMPOUND

The procedure in filling the completed joint with compound was as follows: The vacuum pump was started with all valves and cocks closed to test the tightness of the connections. Then cocks 4 and 7 were opened to test the receiving chamber. Valve 1 was next opened to determine whether the lead sleeve and connections with it leaked. Last in the testing preliminaries, valve 2 was opened. If 27 in. of vacuum was maintained after each of these successive operations the pumping was continued for fifteen minutes. By connecting a vacuum gage to a splice in an adjacent manhole 300 ft. away, it was observed that a 7-in. vacuum was obtained. It was also found that at least 28 in. and, in a number of cases, 29 in. of vacuum was maintained during the last ten minutes of the pumping period.

After pumping had been concluded valve 2 was closed to prevent compound rushing into the joint when valve 1 was opened, and possibly forming a pocket in the splice by taking the short route between the compound entrance and the vacuum connection. Valve 3 was then opened to bring compound down to valve 2, which was subsequently slowly opened, thirty seconds being required for this operation. Cocks 4 and 7 were then closed to prevent the gage and suction connections being filled with compound, which rushed in as valve 1 was opened to admit compound to the receiving chamber. Compound was allowed to rise in the receiving chamber until a layer of clear compound was observed in the lower half of the chamber through a glass window provided in one end. Valve 2 was then closed to stop the flow of compound and cock 5 opened to admit atmospheric pressure and compress the compound in the splice. Valve 2 was then opened to flood the splice at atmospheric pressure, and the remaining valves were closed and the apparatus disconnected.

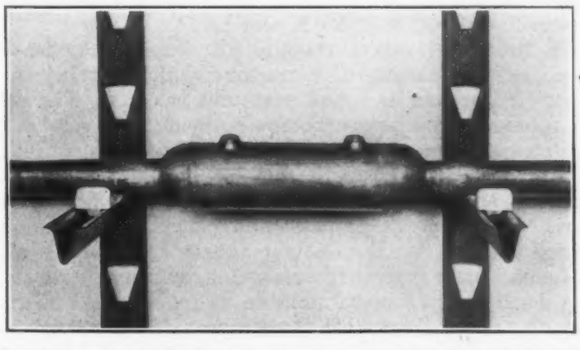


FIG. 4—COMPLETED CABLE JOINT WITH APERTURES CLOSED BY PLUGS

FIG. 5—JOINT-FILLING APPARATUS MOUNTED ON ELECTRIC VEHICLE

COMPENSATING FOR ABSORPTION OF COMPOUND BY CABLE

After the suction and filling apparatus was disconnected a 1-in. pipe nipple with a coupling attached to provide a female thread for the splice plug was connected to one end of the splice and in the other end was screwed a self-acting grease cup. Compound was poured in the cup in a liquid state and permitted to overflow through the nipple at the other end of the splice. When a clear surface of compound was presented at the nipple the plug was screwed in. The cup was then filled with compound and the T-handle screwed up to the highest point so the spring-actuated piston would feed compound into the splice while contraction of the compound due to cooling or absorption by the cable was in process.

After twenty-four hours the grease cup and the nipple on the other end of the splice were substituted by plugs if the amount of compound absorbed by the splice appeared normal.

The Interpretation of Electromagnetic Units*

A Discussion of Certain Inconsistencies in Fundamental Units of Conventional Electric and Magnetic Systems, with Suggestions for Their Removal

BY PROF. DR. M. ASCOLI

THE discussions which have in recent years been held in the meetings of the International Electrotechnical Commission, and particularly in its special committee on nomenclature and symbols, as well as certain proposals resulting therefrom, have confirmed the writer in the belief that serious misunderstandings abound at the present time in the interpretation, or at least in the expression, of the fundamental theory of electromagnetic quantities on which the electric units are based. It seems, therefore, desirable to call attention to certain inconsistencies which have appeared from time to time, in writings on this subject, since the Paris congress of 1881.

Absolute Systems.—The term "absolute system" is often applied in the limited and inaccurate sense of a system whose fundamental units are length, mass and time. The term is likewise often restricted to systems employing such units as the centimeter, the gramme and the second. The term "absolute unit" was actually introduced into science, however, merely in contradistinction to the term "arbitrary unit." For this reason, an absolute system should be understood as a system of derived units, in which the fundamentals expressing physical laws, without employing any conventions or arbitrary numerical relations, reduce the number of basic selective units to the minimum possible number.

In the case of a dynamical absolute system the minimum number of basic selective units is three. But it is by no means necessary that these three should be length, mass and time. For one or more of these three it is possible to effect suitable mechanical substitutions. To each group of three selected basic units corresponds a particular absolute system, the relations between the similar units of the different possible systems being established by the equations expressing the laws of dynamics.

In the case of an electrical absolute system the erroneous view was originally held that likewise only three fundamental basic selective units were needed, and ever since the Paris congress of 1881 this mistake has been repeated again and again in the literature of the subject. Even to-day this error has by no means completely disappeared.

In order to illustrate the effects of such omissions in the electromagnetic systems, we may first consider a little more closely the corresponding conditions in purely dynamical systems.

Dimensional equations serve two purposes—first, they reveal the dimensions of the various derived units with respect to the fundamental units of the system; second, they define the magnitudes of the various derived units. The first purpose is served by the expression of a derived unit in exponential terms of, say, L, M and T, the exponents being characteristic for each derived unit and affording a check upon the homogeneity of any equation containing the unit. The second purpose is served by determining the magnitude of the derived unit in terms of the fundamental magnitudes of, say, length, mass and time.

We may present the dimensional equations of the following six dynamical quantities, mass $[M]$, density $[\delta]$, force $[F]$, energy $[W]$, modulus of elasticity $[E]$, and coefficient of elasticity $[K]$, in three different systems, namely, (I) in terms of mass, length and time, (II) in terms of density, length and time, (III) in terms of elasticity, length and time.

TABLE OF DIMENSIONAL EQUATIONS

Dynamical Quantity	System I $[M]$ $[L]$ $[T]$	System II $[\delta]$ $[L]$ $[T]$	System III $[E]$ $[L]$ $[T]$
1. Mass	$[M]=[M]$	$[M]=[\delta L^3]$	$[M]=[ELT^2]$
2. Density	$[\delta]=[ML^{-3}]$	$[\delta]=[\delta]$	$[\delta]=[EL^{-1}T^2]$
3. Force	$[F]=[MLT^{-2}]$	$[F]=[\delta L^4T^{-2}]$	$[F]=[EL^2]$
4. Energy	$[W]=[ML^2T^{-2}]$	$[W]=[\delta L^5T^{-2}]$	$[W]=[EL^3]$
5. Modulus of elasticity	$[E]=[ML^{-1}T^{-2}]$	$[E]=[\delta L^2T^{-2}]$	$[E]=[E]$
6. Coefficient of elasticity	$[K]=[M^{-1}LT^2]$	$[K]=[\delta^{-1}L^{-3}T^2]$	$[K]=E^{-1}$

Commencing with system I, we have from equation (2) the relation $[M] = [\delta L^3]$. Substituting this value for $[M]$ throughout, we obtain system II. In this system the fundamental unit of density might be that of any conventional standard medium, either actual or ideal. For example, air under specified conditions might be the chosen medium, or an ideal medium might be chosen having a density, say, 100 times greater than standard air, which would then have a density of 0.01. The unit of mass would be the mass of unit volume of the standard medium.

It is important to observe that, comparing the two equivalent systems I and II, the dimensions of any given quantity, in terms of the units L and T, which remain common to both, are not the same. Thus force has the exponents of L changed from 1 to 4. We may thus infer that if the dimensions of derived quantities differ it is because of differences in the nature of the fundamental units on which the systems are based.

System III may be derived from system I through equation (5) of the latter, which gives $[M] = [ELT^2]$. Substituting this value for $[M]$, we obtain the dimensional equations of system III, which employs elasticity as one of its fundamental units. The unit of elasticity is that of some arbitrary medium, real or ideal. Equating any of the corresponding expressions in systems II and III, we obtain $[E\delta^{-1}] = [L^2T^{-2}]$, a dimensional equation corresponding to the Newtonian law

$$V = \sqrt{\frac{E}{\delta}},$$

which expresses the velocity of sound in a medium possessing the properties E and δ.

In the ELT system, the unit of density may be defined as the density of a medium which, having unit elasticity, transmits sound with unit velocity. The unit of mass would likewise be the mass of unit volume in such a medium.

The preceding absolute systems have been selected, not for any practical advantage that may pertain to them, but in order to present a close formal analogy which they bear to the electromagnetic and electrostatic systems. If in system II we assume, by convention, that the density δ is a mere numeric, it follows that energy has the dimensions $[L^5T^{-2}]$; whereas if in system III we assume by convention that the elasticity E is a mere numeric, it follows that energy has the dimensions $[L^3]$.

*Abstract and translation by Dr. A. E. Kennelly, graduate School of Applied Science, Harvard University, of a paper published Nov. 25, 1915, in *L'Elettrotecnica*, the official organ of the Associazione Elettrotecnica, Italiana, Vol. II, p. 731.

It is by such suppression of dimensions in the fundamental units of the conventional electric and magnetic systems that the ratios of dimensions of the same derived units in the two are some power of a velocity, whereas they should evidently be mere numerics. It may thus be inferred that, since different dimensions appear in the electric and the magnetic systems for one and the same derived unit, there exists at least one suppressed unit dimension in each of the fundamental groups; so that in addition to M, L and T there is at least a fourth fundamental unit, involved but suppressed. Thus, in the conventional electromagnetic system, the dimensions of current are $[I] = [M^{\frac{1}{2}}L^{\frac{1}{2}}T^{-1}]$, whereas in the electrostatic system, they are $[I] = [M^{\frac{1}{2}}L^{\frac{3}{2}}T^{-2}]$. In the same way it is frequently claimed that the dimensions of inductance are essentially those of a mere length, and that those of a resistance are essentially the same as those of a velocity. The absurdity of such contentions would be manifest if we set about expressing the height of a mountain in henrys, or the speed of a train in ohms. The expression of an inductance or of a capacitance in centimeters offends the trained ear almost as much as to hear weights expressed in gallons or distances in pounds. By taking the density of water as unity in the metric system, the weight of a given volume of water becomes numerically equal to this volume, but that does not logically permit of expressing a weight in units of volume.

In a similar manner, it is a fundamental error to express a magnetic flux density as homogeneous in dimensions with a magnetic force. An equation of the type $\mathfrak{B} = \mathfrak{H} + 4\pi\,\mathfrak{I}$ may be expressed as a numerical equality with reference to a given system of units, but cannot be expressed as a physical identity. If the unit system be changed the numerical equality will disappear. The same is true for the equation $\mu = 1 + 4\pi\varkappa$. These equations are incomplete or non-homogeneous. When properly written out in full, they become respectively

$$\mathfrak{B} = \mu_0\,\mathfrak{H} + 4\pi\,\mathfrak{I} \qquad \text{and} \quad \mu = \mu_0 + 4\pi\varkappa,$$

where μ_0 is the permeability of free space. For this reason, the proposal of the International Electrotechnical Commission to express both $\mathfrak{H}$ and $\mathfrak{B}$ in terms of one and the same unit (the gauss) is logically inadmissible. It would be equivalent to adopting, in the international metric system, the same unit (the cubic meter, say) for both masses and volumes.

The experimental facts upon which the quantitative science of electromagnetism rest are, when written algebraically:

force	$f = \frac{1}{\varepsilon}\frac{QQ'}{l^2}$,	Coulomb's law of electric action;
force	$f = \frac{1}{\mu}\frac{mm'}{l^2}$,	Coulomb's law of magnetic action;
force	$f = \frac{2}{\lambda}\frac{mI}{l}$,	the Biot and Savart law of electromagnetic action;
current	$I = \frac{Q}{t}$,	Rowland's law of current identity;

where ε is the dielectric constant, μ the inductivity, and λ the electromagnetic constant of the medium. Here, in addition to L, M and T, six electromagnetic quantities enter, namely, ε, μ, λ, Q, m and I. These four equations can only serve to define four of them as functions of the other two, and of L, M, T. In the absence of any new experimental relations, no derived unit can add to the solution. The minimum number of fundamental units which can serve jointly as a basis for such a system is therefore five, and if three of these are, as usual, M, L and T, two others must remain either acknowledged or else concealed and suppressed.

If we retain, for the sake of logical completeness, the three constants ε, μ, and λ, we may recast our fundamental equations in the following forms:

$$f = \frac{1}{\varepsilon}\frac{Q^2}{l^2} \quad \text{force;} \qquad W = \frac{4\pi}{\lambda}mI \quad \text{work;}$$

$$f = \frac{1}{\mu}\frac{m^2}{l^2} \quad \text{force;} \qquad v = \frac{\lambda}{\sqrt{\varepsilon\mu}} \quad \text{velocity.}$$

From these the various derived units may be obtained, as follow:

$$\text{Electric force, } F = \frac{f}{Q} = \frac{1}{\varepsilon}\frac{Q}{l^2}.$$

$$\text{Magnetic force, } \mathfrak{H} = \frac{f}{m} = \frac{1}{\mu}\frac{m}{l^2}.$$

$$\text{Electric potential, } V_e = Fl.$$

$$\text{Magnetic potential, } V_m = \mathfrak{H}\,l.$$

$$\text{Electric flux of } F, \ \Phi_f = \frac{4\pi}{\varepsilon}Q.$$

$$\text{Magnetic flux of } \mathfrak{H}, \ \Phi_b = \frac{4\pi}{\mu}m.$$

$$\text{Electric displacement, } D = \varepsilon F.$$

$$\text{Magnetic induction, } \mathfrak{B} = \mu\,\mathfrak{H}.$$

$$\text{Electric displacement flux, } \Phi_d = 4\pi Q.$$

$$\text{Magnetic induction flux, } \Phi = 4\pi m.$$

$$\text{Magnetic moment, } ml.$$

$$\text{Magnetic intensity, } \mathfrak{I} = \frac{m}{l^2}.$$

$$\text{Electrostatic capacitance, } C = \varepsilon l.$$

In the above expressions l means a length, or, more strictly, it is a quantity having the dimensions of length and therefore expressible in units of length.

In deriving the meaning and dimensions of inductance we may define it in any one of three ways, namely:

(1) In terms of the mutual energy of two electric currents I and I', which reduces to $W = \frac{\mu l}{\lambda^2}II'$. From this, their mutual inductance is $\mathfrak{M} = \frac{\mu l}{\lambda^2}$.

(2) In terms of the magnetic flux emanating from one current I and linked with another current I', which reduces to $\Phi = \frac{\mu l}{\lambda}I'$. From this, the inductance of a current on itself is $\mathfrak{L} = \frac{\mu l}{\lambda}$.

(3) In terms of the emf. induced in one circuit by the rate of change of flux emanating from a neighboring circuit carrying current, which reduces to

$$E = -\frac{\mu l}{\lambda^2}\frac{dI}{dt}$$ From this the inductance of a current on itself is $\mathfrak{L} = \frac{\mu l}{\lambda^2}$

It is evident that if we give to the electromagnetic constant λ the arbitrary value of unity, all three definitions of inductance become identical in dimensions; but otherwise they will differ, (1) and (3) being equivalent to but not in agreement with (2). The latter (2) is logically preferable, being based on the phenomena of magnetic induction, to which the unit directly refers. The three definitions may, however, be brought into conformity if instead of considering the flux of vector magnetic induction $\mathfrak{B}$, we should consider the flux of the vector $\mathfrak{B}/\lambda$, which might be called, for distinctiveness, the electromagnetic induction. The flux of this vector would be

$$\Phi = \frac{\Phi}{\lambda} = \frac{\mu l}{\lambda^2}I',$$

which, substituted for Φ in (2), would give $\mathfrak{L} = \frac{\mu l}{\lambda^2}$, in accordance with (1) and (3). In this manner the in-

ductance would be defined as the flux of electromagnetic induction linked with a circuit carrying unit current.

The definition contained in (1) offers an answer to a question raised in the symbols committee of the International Electrotechnical Commission as to whether inductance should be regarded as an electric or as a magnetic unit. This definition enables both λ and μ to be eliminated, leaving ε solely in evidence as a distinctively electric unit. Moreover, the inductance multiplied by an angular velocity—*i.e.*, divided by a time—becomes a reactance, essentially similar to a resistance, which is an electric unit.

In conclusion, we may bring together some of the more important quantities and their dimensions in terms of λ, μ_0, L, M and T. These expressions permit of varying at will the numerical magnitudes of the units by suitably attributing a numerical value to λ.

$$[Q] = [\lambda\mu^{-\frac{1}{2}}M^{\frac{1}{2}}L^{\frac{1}{2}}] \qquad [E] = [\lambda^{-1}\mu^{\frac{1}{2}}M^{\frac{1}{2}}L^{\frac{3}{2}}T^{-2}]$$
$$[I] = [\lambda\mu^{-\frac{1}{2}}M^{\frac{1}{2}}L^{\frac{1}{2}}T^{-1}] \qquad [R] = [\lambda^{-2}\mu LT^{-1}]$$
$$[\mathfrak{H}] = [\mu^{-\frac{1}{2}}M^{\frac{1}{2}}L^{-\frac{1}{2}}T^{-1}] \qquad [\mathfrak{L}] = [\lambda^{-2}\mu L]$$
$$[\mathfrak{B}] = [\mu^{\frac{1}{2}}M^{\frac{1}{2}}L^{-\frac{1}{2}}T^{-1}] \qquad [C] = [\lambda^{2}\mu^{-1}L^{-1}T^{2}]$$
$$[\Phi] = [\mu^{\frac{1}{2}}M^{\frac{1}{2}}L^{\frac{3}{2}}T^{-1}]$$

We may, for example, find what numerical value of λ will change the magnitudes of the units of mass and length so that these shall coincide with those of the practical system of the ohm, volt and ampere.

The practical system is an absolute system, having as unit of length 10^9 cm. and as unit of mass 10^{-11} gm. The result is that the practical units of quantity Q and current I are 10^{-1} of the corresponding c.g.s. units. The corresponding ratios for the practical units of E, R, $\mathfrak{L}$ and C are well known to be 10^8, 10^9, 10^9 and 10^{-9}. If we were to take the kilogram and the meter as the units of mass and length, and if we assigned to λ the value $10^7/\pi$, or 3162, with $\mu_0 = 1$, we should have all the units of the λ, μ_0, m., kg., s. system identical with those of the existing practical system.

We may therefore say that the ohm, coulomb, ampere, volt, farad, henry, joule, watt, and the unit permeability of free space, are all the units of the absolute μ_0, m., kg., s. system, when λ is given the numerical value 3162. This system is put forward merely to indicate the importance of giving recognition to the coefficient λ. It may be observed, however, that the μ_0, m., kg., s. system is based upon precisely the same foundations and physical laws as the μ_0 c. g. s. system, except for the assignment of a specific numerical value to λ.

Giorgi, in some important papers published between 1901 and 1904,* proposed and developed an absolute system of electromagnetic units which, besides offering rationalization, took as its fundamental selective units the meter, kilogram, second and the international ampere (or any one of the Chicago units). The magnetic permeability μ_0 of free space here differs from unity, and became $4\pi \times 10^{-7}$. This system suppresses the superfluous 4π factor in electromagnetic equations. It has, however, the disadvantage of requiring very awkward numbers for permeabilities. To remedy this inconvenience, Giorgi proposed to substitute the term magnetic inductivity for permeability, reserving the use of the latter term for the ratio between the inductivity of a substance and that of free space. In this way the existing numerical values of permeability would remain unchanged. The system above referred to, however, as the μ_0, m., kg., s. system is free from this complication, and shows that other means exist for attaining the advantages of the meter and kilogram as units, without departing from the international practical system.

*See *Transactions* International Electrotechnical Congress, St. Louis, 1904. Section A, Vol. I, p. 130, "On the Systems of Electric Units," by Prof. Dr. M. Ascoli, honorary vice-president.

Opportunities for Young Electrical Engineers

III—In the Electric Railway Field

By Charles Rufus Harte

Construction Engineer The Connecticut Company, New Haven, Conn.

It is probably in the work of electric railway operation and administration, points out Mr. Harte, that the openings for the young electrical graduate promise the most consistent development. In the operating field referred to, many large questions still remain and there is an infinity of small problems the solution of which will mean who has decided up on electric railway work of the aggregate than the more obvious major problems. Moreover, it is in many ways desirable that the candidate for honors in other branches of the electric railway field shall have had a preliminary training in operation, and the young man who has decided upon electric railway work of any kind will find a first-hand knowledge of operation well worth the time needed to acquire it.

Of the army of young men who are each year graduated from our technical schools, a few, usually because of family ownership or control of properties, have had, in advance, definite lines of work determined, often even from childhood, and a few more, because of particular aptitude or liking for a certain branch of work, have clear ideas as to what they will do. The majority, however, face graduation not only undecided as to what work to take up, but often with little realization of the fields open. To this undecided contingent a brief statement of the opportunities of electric railway work may not be amiss.

Of the four interrelated branches of electric railway work, research and production are developed with reference to the entire electrical art, and to some extent this is also the case with construction. With the larger companies, however, and with some contracting firms, there is here opportunity for specializing, and the field offers endless and constantly changing problems, particularly in the direction of heavy service electrification. But it is in the branch of operation—employing the term here in its broader sense of embracing all developments and administration other than that of entirely new work—that the openings promise the most consistent development.

Naturally enough, the first thoughts along this line of the technical near-graduate is of maintenance, of power, of lines, or of track, and his conclusions are usually summed up with the conviction that while here there may be a measure of reward there is no opportunity for individual effort other than doing well what others have long done before. This, however, is a mistaken view. It is true that there are not the opportunities for such personal glory and financial return as that which, for example, awaits the man who develops a practical method of converting the energy of

coal into electricity without the great present losses, or who provides a more practicable method of transporting electricity than the present "storage" battery—to mention but two of the urgent research problems. But there are many large questions, and an infinity of small ones, the answers to which in the total mean economies and advances of no less importance, to say the least, than the more obvious major problems.

Aside from the more purely engineering work, however, the field of management and operation proper should attract the technical graduate. In fact, the young man who has decided upon any electric railway work will find a first-hand knowledge of operation well worth the time needed to acquire it. Operation does not offer such public glory as may be had in some other fields; indeed, in these days the head of a large system when in public is less likely to be the subject of high honors than the object of curiosity as to how he conceals his horns and tail, but the solution of the problems in diplomacy, administration and finance involved in balancing satisfactorily the desires of the public, the claims of labor, the rights of the stockholders, and the shrinking purchasing power of the nickel, requires the true engineering temperament, although technical training in detail is less a necessity than is sterling common-sense.

Men whose characteristics or inclinations point toward special fitness for one of these fields need have no fear of lack of opportunity or reward in it, nor need the average graduate, doubtful as to his real place, hesitate on that account. The differing lines are not so dissimilar that time spent in one is lost if presently it appears a wrong choice has been made. Indeed, as already stated, it is in many ways desirable that the candidate for honors in other directions have a preliminary training in operation. Success in any line comes as the result of many characteristics, often widely different in detail in different men, and consideration of the histories of successful men shows clearly that adverse circumstances of early training and work at least have not prevented final achievement—if they have not been favorable factors.

The situation may well be summarized in the statement that to the young technical graduate the field of electric railway work offers great opportunity; that in no branch are the problems by any means exhausted, and that the rewards for success are well worth while, both professionally and financially.

Discussion by Readers

Herewith are reproduced two of the letters received commenting on the preceding articles of this series, printed in the issues of Jan. 15, Feb. 19, and March 18. The editors will gladly publish communications which will help the young electrical engineer get his sense of direction in a great industry.

To the Editor of ELECTRICAL WORLD:

SIR: Your introductory article on "The Young Electrical Engineer's Opportunities" (Jan. 15) opens with the statement that next June about 1600 young men will be graduated in electrical engineering. They will find but little difficulty in securing employment at laborers' wages, and most of them will be obliged to begin their career without their college education having raised their initial economic value above that of an illiterate. There are two reasons for this.

A college education has no value unless there is something to educate. Graduates will be employed at low wages until they have shown that their education is backed by character and ability. Those who succeed in this test, however, will not receive as much compensation as their employers can afford to pay, because competition is so severe that in most cases they can be quickly replaced by outsiders who would be perfectly satisfied to receive the same salaries.

Economists tell us that value is proportional to the ratio of demand to supply and that this law applies to labor as well as to commodities. Every graduate adds to the supply and trusts to luck for the demand. He enters electrical engineering because its mysterious science appeals to him or because in his early youth a fond parent thought he was born to be an engineer on account of his aptitude in taking apart his first dollar watch.

The boy entering college does not know enough of the world to think of supply and demand. This should be done for him by parent or college. The parent is often as helpless or thoughtless as the boy, so the duty of regulating the supply to the demand should devolve upon the college. The college, however, would find this a difficult task because of its remoteness from business affairs. The solution of the difficulty, in my opinion, is co-operation between the colleges and the engineering societies. The colleges meet the engineers and the engineers meet the industries in these societies, thus furnishing an ideal means of keeping the college in touch with industrial demands.

There are many industries which are run in an inefficient, haphazard way owing to the lack of high-grade technical talent. I am of the opinion that this is true of a large proportion of our industries and public-service corporations. Lawyers, politicians and merchants occupy positions requiring engineering knowledge for their efficient administration. Our colleges should prepare men for this work instead of turning out hundreds of machine designers, surveyors, and so on. The realization of such a plan would require the close co-operation of the colleges and industries, and who is better fitted to bring out this result than the great engineering societies?

Your series of articles is apparently designed to assist the graduate in finding himself after his parents and teachers have set him adrift. The articles will undoubtedly be read with profit, but why are the boys set adrift? Why can't they be properly launched from ships carefully built under the official supervision of the engineering profession? WILLIAM A. DELMAR,

Interborough Rapid Transit Company.
New York, N. Y.

To the Editor of ELECTRICAL WORLD:

SIR: I have become very much interested in your series of articles "Opportunities for Young Electrical Engineers." I believe these will be of great benefit not only to the student about to graduate but also to those who have been out of school some little time, to faculties of engineering schools, and many others.

Already there have been brought forward several points worthy of considerable meditation and discussion, of which by your kind invitation advantage has been taken by several of my colleagues. A most important point brought up and deserving emphasis seems to be the question of including in school records personal characteristics such as:

Pleasing personality,	Broad and open-mindedness,
Address,	Diplomacy,
Self-confidence,	Foresight,
Judgment,	Industry,
Aggressiveness,	Reliability,
Habits,	Health.

These characteristics are the ones looked for by the employer. They are important items in the marking systems of the large manufacturing and central-station companies conducting apprenticeship courses. Most of us, I think, will agree that they contribute in no small measure toward success.

Several universities and colleges have been collecting data on the personal characteristics of their students for some time, and I believe I am safe in saying many others have been contemplating similar analysis. It seems to me the need for this is urgent, since success depends to a considerable extent on proper characteristics, a fact very little appreciated by the student until he reaches the outer world. Some system of considering these traits in students would early bring the matter forcibly before them, with the probability of their immediate effort and improvement. R. W. GODDARD,

Department of Electrical Engineering, New Mexico College of Agriculture and Mechanic Arts.

Fan Motor Installations that Minimize Vibration

Methods of Mounting Blowers and Motors—Special Foundations and Sound-Proof Housings

BY T. W. REYNOLDS

Unless special attention is paid to the method of mounting blowers and motors the vibrations set up during operation may be transmitted for considerable distances from the equipment by the air currents or by the framework of the building in which the apparatus is installed. The writer has found that very little trouble has been experienced, however, from vibration when the construction indicated in the accompanying drawings and recommended by R. D. Kimball Company, consulting engineers, New York City, has been used.

The foundation on which the apparatus is set is made of concrete or brick to provide a firm base. Between this and the base of the machine is placed a resilient sub-base set on 4-in. x 6-in. x 1-in. piano-felt pads placed 3 ft. apart, the whole being secured in position by bolts anchored in the foundation and heads countersunk in the sub-base. The sub-base consists of a lower layer of 4-in. x 6-in. or 4-in. x 8-in. spruce or other soft-pine timbers laid flat and lengthwise of the foundation. Across these is laid a flooring consisting of ⅞-in. soft-pine boards covered with two 2-in. layers of hard-pressed "Nonpareil" cork separated by one layer of No. 24 galvanized-iron sheets. Around the border of the upper layer is laid an oil-dressed hard-pine coping framed

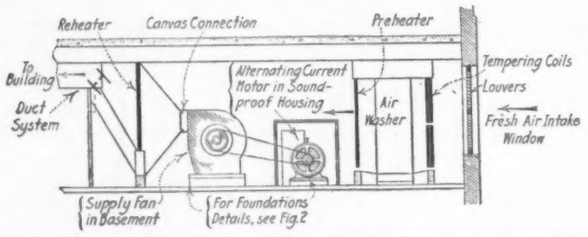


FIG. 1—MOUNTING OF BLOWER APPARATUS AND CONNECTIONS WITH DUCT SYSTEM TO PREVENT TRANSMISSION OF VIBRATIONS

with lap joints. The size of timbers required for the coping depends on the size of the apparatus to be supported. For instance 3-in. x 8-in. timbers should be used with small-sized fans such as the steel-plate paddle-wheel type with an 80-in. housing. With 90-in. to 120-in. fans 4-in. x 12-in. timbers are advisable, and for larger units 5-in. x 12-in. timbers are recommended. The size of copings used under driving units should correspond to those under the fans. After the coping has been set in place ⅛-in. sheets of lead should be laid on the surfaces on which the machine base will bear and the latter bolted to the coping with lag screws equipped with rubber bushings, hard-rubber washers, and steel washers in the position indicated in Fig. 2.

With this done the space over the upper layer of cork between the coping timbers is filled with concrete to within ½ in. of the machine base. This provides extra weight and rigidity without decreasing the resiliency of the sub-base. It may be pointed out that in the construction which has been described the aim has been to eliminate all rigid connections between the machine and its foundation, as exemplified by the use of rubber washers and bushings for lag screws, countersinking of anchor bolts to avoid contact with machine base and the like. When apparatus is set in basements, propagation of vibrations from a machine may be minimized by placing 2 in. of asphalt or sand under and around the masonry foundation.

In some instances alternating-current motors must be used to drive fans, in which case two-phase or three-phase units are preferable since single-phase units, even when equipped to be self-starting, are objectionable because they usually produce considerable noise due to the pulsating flux, especially in large sizes. Extra precautions should be observed in selecting motors rated

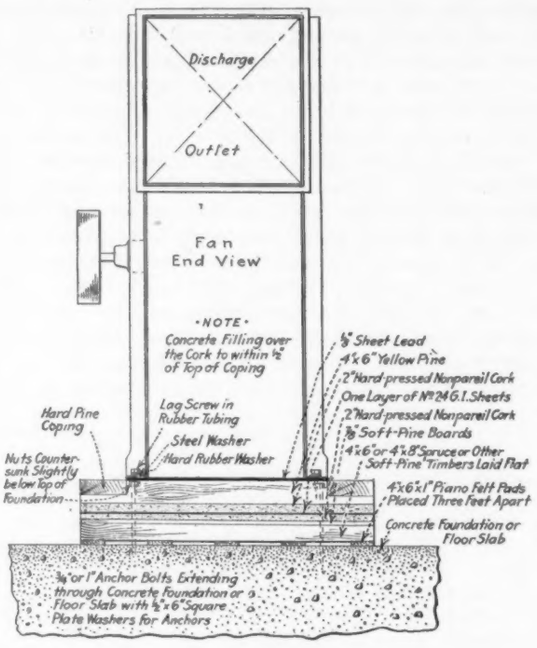

Discharge
Outlet
Fan End View
·NOTE·
Concrete Filling over the Cork to within ½" of Top of Coping
⅛" Sheet Lead
4"x6" Yellow Pine
2" Hard-pressed Nonpareil Cork
One Layer of No. 24 G.I. Sheets
2" Hard-pressed Nonpareil Cork
⅞" Soft-Pine Boards
4"x6" or 4"x8" Spruce or Other Soft-Pine Timbers Laid Flat
4"x6"x1" Piano Felt Pads Placed Three Feet Apart
Concrete Foundation or Floor Slab
Hard Pine Coping
Lag Screw in Rubber Tubing
Steel Washer
Hard Rubber Washer
Nuts Countersunk Slightly below Top of Foundation
¾" or 1" Anchor Bolts Extending through Concrete Foundation or Floor Slab with ½"x6" Square Plate Washers for Anchors

FIG. 2—FAN OR MOTOR FOUNDATION THAT MINIMIZES NOISE

at less than 2 hp. to secure quietly-operating units. When motors have been purchased which do not operate quietly they should be inclosed in sound-proof housings, especially when they must be installed in the air passage to the blower. The housing may be constructed with a lining of hair felt held in place with ⅛-in. asbestos sheets. This makeshift should be avoided, however, where possible by the selection of suitable apparatus.

To prevent the transmission of vibrations from fan housing to the duct system, flexible duct couplings may be inserted between the fan and the discharge duct.

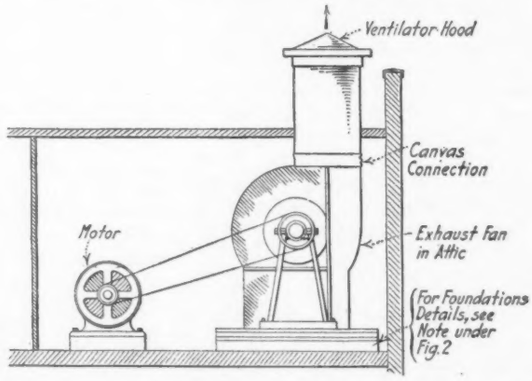


FIG. 3—EXHAUST-FAN HOUSING THAT MINIMIZES TRANSMISSION OF VIBRATIONS

These couplings may be constructed of two layers of 10-oz. canvas shaped into a sleeve about 8 in. long (depending on the size of the fan) and fastened to the fan and duct by means of collars bolted to each. Slack should be provided in the sleeves to allow for inflation, and each layer should be painted with four coats of the best lead and oil paint.

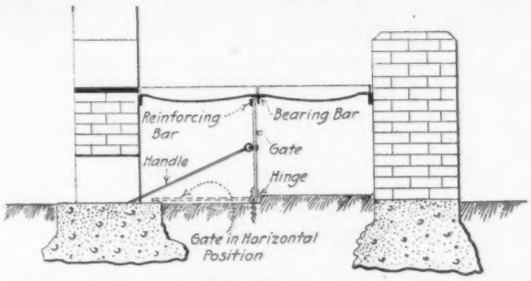
STATION AND OPERATING PRACTICE

A Department Devoted to Problems of Installation, Operation and Maintenance of Equipment for Economical Generation and Distribution of Electrical Energy

Maintaining Fire on Portion of Grates to Improve Light-Load Efficiency

BY A. E. ANDERSON

In small generating stations with ordinary load-factors the rating of each boiler is sometimes four to ten times the amount needed to carry the load at different times of the day. Under these conditions a thick fuel bed is undesirable and a thin one without holes is difficult to maintain. The result is that unnecessarily large quantities of air often pass through the grate and past the boiler tubes, thereby lowering the efficiency of combustion and utilization of energy in the fuel. For financial reasons and because of the possible growth in load, it is not always advisable to try to remedy this condition in small plants by installing several differently rated boilers for as many different loads, since acquisition of new business may change the load so that the boilers installed are no longer the most suitable in regard to all-day efficiency.



ASH-PIT GATE TO PERMIT FIRING OF HALF-GRATE ONLY

The writer has found, however, that by providing means for burning fuel on only a portion of the grates and preventing air leaking through the remainder boilers can be operated at almost as high efficiency as if they were run at rating. To permit this method of operation in the writer's station a sheet-iron gate was hinged to the floor of the ash pit directly under the bearing bar supporting the middle ends of the two sets of grate bars, as shown in the accompanying drawing. One end of a rod was fastened near the upper edge of the gate so that it can be raised or lowered by hand from the front of the boiler as load conditions demand.

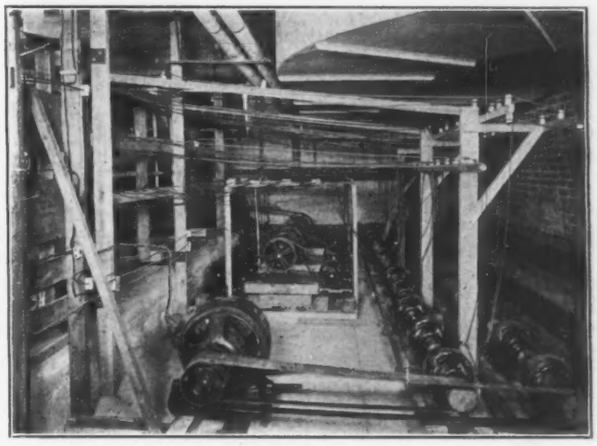
When there is a load of 50 per cent to 100 per cent of the rating of the boiler the gate is placed in the horizontal position so that fire may be maintained on the entire grate surface. With light loads, however, the gate is raised to prevent air reaching the rear half of the grates and a fairly thick fuel bed maintained without holes on the front half. The rear grates are kept covered with cinders and clinkers to prevent the grate bars burning. The floor back of the gate can be raised even with the gate in its horizontal position to eliminate the difficulty of drawing cinders from the back of the pit over the gate.

A so-called movable bridge wall to accomplish the same purpose as the gate has been placed on the market, but while it should meet long-needed requirements operating troubles are liable to develop where high temperatures, overload conditions and slag formation occur even for a few hours.

The effectiveness of the ash-pit gate or half-grate device can be readily tested, without much expense. For instance, choose a time, say after midnight, when the load remains fairly constant and is about the same each day. Weigh the coal used for a certain period, say three or four hours, when firing the boiler in the usual manner. Then during the corresponding period on the next day thoroughly cover the rear half of the grates with cinders and weigh the coal used with a fire maintained only on the front half of the grate. A saving of 5 to 15 per cent will result, depending on the care with which the test is conducted.

Investigation of Direct-Current Corona at the University of Illinois

During the last three years the electrical-engineering department of the University of Illinois has been carrying on investigations of phenomena accompanying the production of high dielectric stresses in air. Potential differences ranging from 500 volts to 30,000 volts are used to produce these dielectric stresses. The investigations have been confined entirely to the study of the corona characteristics as found when continuous potentials are applied between small wires and cylindrical tubes, the wires being strung axially along the tubes. The investigation apparatus took these forms because it has been found that the intensity of the corona discharge when the wire is connected to the positive side of the line differs very materially from the discharge when the wire is connected to the negative side of the line. These two conditions can be studied separately and independently best when the direct-current potentials are used. Another reason why the wire-cylinder form of apparatus was chosen is because the field distribution between the wire and the tube is extremely simple and symmetrical as compared with the distribution obtained between two parallel lines.



A GROUP OF 250-WATT, 500-VOLT DIRECT-CURRENT GENERATORS CONNECTED IN SERIES TO PRODUCE HIGH POTENTIALS FOR INVESTIGATING CORONA

The plant used for the production of high-potential direct currents consists of fifty 500-volt, 250-watt shunt

generators. The machines are divided into three sets, and each set is driven by a shunt motor. The armatures of the machines are permanently connected in series, and the field of each machine is connected across its armature. A knife switch is included in each field circuit so that any machine may be excited or allowed to run idle as desired.

The frames of the machines are thoroughly insulated from the ground and the shafts are connected together through flexible insulating couplings. In the newest part of the installation one side of the armature of each machine is connected to the frame of the machine. In this manner the greater part of the dielectric strain is put on the insulation external to the machine, and the strain between the armature winding and the frame is definitely limited to the potential generated in the one machine.

The line potential can be adjusted to give any desired value up to 30,000 volts as a maximum by (a) closing the desired number of field switches, (b) varying the speed of any of the sets, and (c) changing the resistance in the field of the generator connected to the grounded side of the line. The voltage is measured by means of two electrostatic voltmeters, one of the Kelvin type for measuring the higher values of potential used, and the other of the Braun type for measuring the lower values (below 3500 volts). These voltmeters are calibrated from time to time by means of an attracted-disk electrometer.

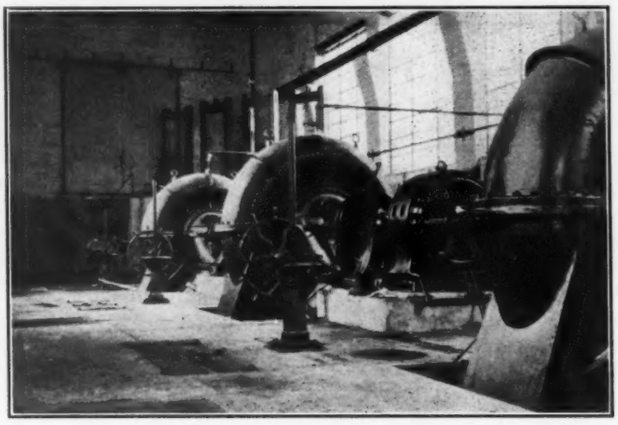
The investigators hope that with the simplified apparatus now in use the laws governing the so-called "positive" (wire positive, tube negative) and "negative" (wire negative, tube positive) corona may be ascertaned and the corresponding formulas developed. It is believed that the laws governing the alternating-current corona discharges can be determined from the two dissimilar direct-current discharge formulas. These facts, together with other data concerning the tests thus far carried on, were set forth in a paper by J. W. Davis and C. S. Breese in a recent issue of the *Technograph*, the publication of the engineering societies of the University of Illinois.

Motor-Driven Pumping Equipment for Preventing Sewer Flooding

To prevent sewers from backing up during flood seasons, thereby flooding basements and interrupting the disposal of sewage, the city of Grand Rapids, Mich., which is located on both banks of the Grand River, has installed electrically equipped sewage pumping stations at the outlets to four trunk sewers. In the East Side station, which is the largest of the four, are four motor-driven centrifugal pumps having a total twenty-four-hour rating of 218,000,000 gal. Two stations on the west side of the city, known as the South Front and West Side Ditch plants, are each equipped with sets of three differently-rated horizontal pumps having total ratings of 63,000,000 gal. per twenty-four hours. The fourth station, known as the Canal Street plant, contains two horizontal pumps having a total twenty-four-hour rating of 24,000,000 gal.

During low-water periods the sewers discharge directly into the river. When the water rises, however, enough to impede discharge from the sewer outlets, sluice gates, which are provided at each station, are closed preventing water backing up into the sewers. Then the pumps, whose suction sides are connected with the compartments formed inside the gates, are started and discharge the sewage into the river.

Energy for operating the motors is received at 4400 volts, but is stepped down before being used. The pumps are said to have exceptionally high efficiency and can be operated at $2 an hour. When there is any rainfall it is usually necessary to keep one of the pumps in each station in operation. At times 50 per cent of the pumping equipment is required, but not until this winter did it become necessary to employ all of the pumps.



MOTOR-DRIVEN CENTRIFUGAL SEWAGE PUMPS IN EAST SIDE STATION, GRAND RAPIDS, MICH.

On one occasion the river rose 12 ft. 6 in. in four hours, a level being reached which was the highest in three years. Although there were misgivings that sewers and basements would be flooded no trouble ensued, since the pumps disposed of the sewage effectively.

Effect of Frequency of Current Reversals on Electrolytic Corrosion

Electrolytic corrosion of iron and lead and the extent to which infrequently reversed currents or alternating currents of commercial frequencies augment it were the chief topics of discussion at a recent joint meeting of the American Institute of Electric Engineers and the New York Section of the American Electrochemical Society held in New York City. In a paper entitled "The Influence of Frequency of Alternating or Infrequently Reversed Current on Electrolytic Corrosion," Burton McCollum and G. H. Ahlborn presented conclusions drawn from experiments performed to determine the coefficients of corrosion of iron and lead buried in soil and subjected to varying frequencies of alternating or reversed currents. Sixty cycles per second was the highest frequency and two weeks the shortest period of investigation. It was pointed out that in the so-called neutral zones of street-railway networks—that is, where the polarities of the pipes are alternately positive and negative for periods not exceeding ten to fifteen minutes—the algebraic sum of the currents discharged is more nearly a correct index to the total damage that will result from electrolysis than any other figure that can be readily obtained.

The investigations also indicated that corrosion of both iron and lead electrodes decreases with increasing frequency of reversal of the current, the corrosion being practically negligible for both metals when the period of the cycle is not greater than about one minute. With iron electrodes a limiting frequency is reached between fifteen and sixty cycles per second, beyond which no appreciable corrosion occurs. No such limit was reached in the lead tests, although it may exist at a higher frequency than sixty cycles. The corrosion of lead reaches practically the maximum value with a frequency of reversal lying between once a day and once a

week. The corrosion of iron does not reach a maximum value until the period of the cycle is considerably in excess of two weeks. With periodically reversed currents the addition of sodium carbonate to the soil reduces the loss in the case of iron and increases it in the case of lead. The coefficient of corrosion of lead under the soil conditions described in the report, when subjected to the action of direct current, was found to be only about 25 per cent of the theoretical value. The reduction in corrosion due to periodically reversed currents appears to be due to the fact that the corrosive process is in a large degree reversible, so that the metal corroded during the half cycle when current is being discharged is in large measure redeposited during the succeeding half cycle when the current flows toward the metal. This redeposited metal may not be of much value mechanically, but it serves as an anode surface during the next succeeding half cycle, and thus protects the uncorroded metal beneath.

The extent to which the corrosive process is reversible depends upon the freedom with which the electrolyte circulates, and particularly on the freedom of access of such substances as oxygen or carbon dioxide, which may result in secondary reactions giving rise to insoluble precipitates of the corroded metal. It is largely for this reason that the corrosion becomes greater with a longer period of the cycle since the longer the period the greater the effect of these secondary reactions.

A Convenient Storeroom Bin and Shelf Construction

In the accompanying illustration is shown a well-arranged storeroom of the Southern Bell Telephone & Telegraph Company at Spartanburg, S. C. The bins at the right are constructed of wood and are 18-in. long, 10-in. high and 18-in. deep. The bins on the left are built of steel 36-in. long, 18-in. high and 20-in. deep, and are used for storing subsets, bells and the like. The shelves and bins on the side of the storeroom not seen in the illustration are of practically the same construction as those shown, except that the wire compartments are larger, accommodating several coils of wire.

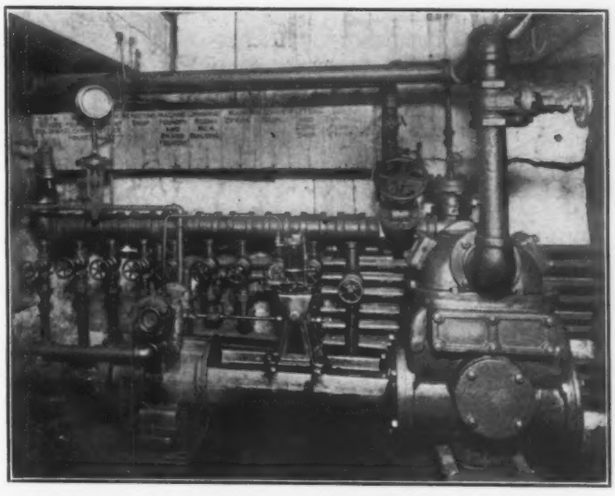
Another feature of this storeroom not shown by the photograph is a work bench, which is equipped with the necessary tools and appliances for cleaning and repair-

THE SPARTANBURG (S. C.) STOREROOM OF SOUTHERN BELL TELEPHONE & TELEGRAPH COMPANY

ing telephones and other equipment. When a telephone is removed from a subscriber's premises, either on account of the discontinuance of the station or on account of trouble, it is brought to the storeroom and placed on this work bench. This subset is then carefully repaired, cleaned and thoroughly inspected, after which it is wrapped in heavy paper and stored in the proper bin. It is the practice at this exchange to always use an inspected telephone at the time of installing a new station or handling a change of location order. When a subscriber changes from one street address to some other location, the instrument at the old location is brought to the storeroom and placed upon the work bench. A new telephone or one that has undergone proper inspection is installed at the new location. In no case is a telephone removed from the old location to the new location and installed without being tested and thoroughly cleaned by the man in the storeroom. This practice was inaugurated more than a year ago by W. W. Collier, district plant chief, and is now considered the best possible insurance against instrument troubles.

How an Arrangement and Marking of Grouped Valves Prevents Mistakes in Manipulation

In the power plant of a Massachusetts factory the high-pressure lines serving various departments and buildings from an air pump are grouped together on



A METHOD OF LABELING SUPPLY LINES FROM A MANIFOLD

a manifold, as shown in the accompanying illustration. To enable the engineers on watch to handle these valves quickly and accurately a board has been mounted on the wall above the manifold with a suitable label and an arrow above each valve. This results in much more rapid valve manipulation than where the hand wheel of the valve itself is tagged and mistakes are minimized by the paralleling of designations, accurately aligned and subject to satisfactory lighting conditions.

Substation Operating Costs for a New England Electric-Railway System

An interesting example of the economies afforded by central-station service was recently brought out at a joint hearing before the Massachusetts and New Hampshire Public Service Commissions in connection with a proposed increase of fares on the Massachusetts Northeastern Street Railway. The company operates an interstate system of 126 miles of track and purchases energy from the Rockingham County Light & Power Company of Portsmouth, N. H. Three-phase, twenty-five-cycle, 13,200-volt alternating-current energy is delivered to seven substations with an aggregate rating of 4500 kw. and a maximum capacity of 6000 kw. for a

few hours. The central-station energy is 1.4 cents per kilowatt-hour, provision being made for slight changes following fluctuations in the price of coal. Energy consumption and power demand are measured at primary voltage upon the alternating-current panels of the substation switchboards, the railway assuming the transforming and conversion losses and operating and maintaining the substations. During the fiscal year 1915 the energy consumption was 10,306,324 kw.-hr., for which the central station received $144,288. In the same period the average loss in the substations was 12.5 per cent, the range being from 8 to 16 per cent, depending on the load-factor, and the railway's direct-current energy consumption was 9,018,023 kw.-hr., or 3.52 kw.-hr. per car-mile. From Oct. 1 to May 1 inclusive forty-two double-truck and six single-truck cars are operated, and the rest of the year the schedule normally requires four single-truck and fifty-seven double-truck cars. Average speed of cars is 11.52 miles per hour.

President Belden of the Massachusetts company said that it is estimated that a generating station of sufficient capacity to meet the maximum power demands of the railway alone and allow for reasonable growth would cost at least $500,000, and that the necessary alternating-current lines would cost $160,000 on the basis of $4,000 per mile, making a total investment of $660,000 if the railway company supplied its own energy. Allowing for a combined charge of 15 per cent to cover taxes, interest, insurance and depreciation on the power plant and 10 per cent for taxes, interest and depreciation on the pole line, the company would have to face yearly charges amounting to $91,000 if it ceased to purchase central-station service. There would also be distribution-line losses between the power house and the substations amounting approximately to 10 per cent, and the expense of maintaining and patrolling the lines, estimated at $150 per mile per year, or $6,000 for the 40 miles of line required.

The cost of substation operation and maintenance for the fiscal year 1915 was $14,317, composed of substation maintenance, $2,562; wages, $10,804, and supplies, $950. The total cost of power purchased, including substation operating and maintenance costs, was $158,605. Mr. Belden said to the commissioners that by purchasing energy the Northeastern company is saved the fixed charges, including interest, taxes, insurance, depreciation and obsolescence on generating plants and distribution systems, that must be assumed by companies producing their own power.

A comparison of the amount now paid the central station by the street railway with the estimated cost to the latter of providing its own power is tabulated herewith. The figures omit substation losses and costs now assumed by the customer, because they would be the same in either case:

Present cost of purchasing energy: 10,306,324 kw.-hr., at 1.4 cents	$144,288.53
Items of cost to railway in producing its own energy:	
Estimated cost of power plant	500,000.00
Annual charges for taxes, insurance, interest and depreciation on power plant (15 per cent)	75,000.00
Estimated cost of 40 miles of transmission line (at $4,000 a mile)	160,000.00
Annual charges for taxes, interest and depreciation on pole line (10 per cent)	16,000.00
Cost of patrolling and maintaining lines	6,000.00
Total charges, exclusive of plant operation	97,000.00
Total kilowatt-hours to be generated	11,451,467
Ten per cent loss between power house and substations, kw.-hr.	1,145,147

The balance left for station operation and maintenance after deducting $97,000 (based on an energy cost corresponding to that with central-station service) is $47,288.53, equal to 0.413 cent per kilowatt-hour. This unit production expense, however, said Mr. Belden, is lower than the average unit cost of coal alone for modern stations in New England.

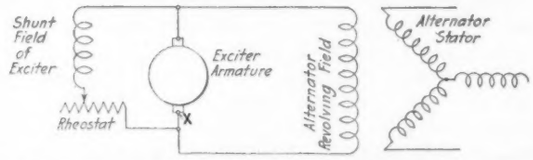
Minimizing Electrolysis of Cable Sheaths

In the April 1 issue of the ELECTRICAL WORLD, page 769, an article appeared which outlined methods used by the Edison Illuminating Company of Brooklyn to ascertain where damage is liable to result from electrolysis and the method used to drain stray currents at these points. These methods were devised and worked out under the supervision of R. A. Paine, Jr., of the distribution department of the Edison Electric Illuminating Company of Brooklyn, and were presented in an elaborate original paper by him before the Brooklyn Company Section of the N. E. L. A. The data and information on these methods as presented in the ELECTRICAL WORLD were based on the information in this paper, the tabulated data and illustrations being those presented by Mr. Paine. This paper was also published in its entirety in the February issue of the *Brooklyn Bulletin* of the Brooklyn Company Section, N. E. L. A.

Correcting Polarity Reversal of Exciters

BY B. W. DAVID
Electrical Engineer Lincoln Electric Company

In an article of the March 18 issue of the ELECTRICAL WORLD, page 658, Gilbert Rutherford described conditions whereby the polarity of a direct-connected or individual exciter may be unintentionally reversed when the voltage of the exciter is too quickly reduced. This annoyance is therein described and properly explained as resulting from the discharge of the large alternator field back through the shunt field of the exciter. In what follows the writer offers an easy solution to the problem of restoring the exciter to its normal condition so that the meters will again read "on scale."



CONNECTIONS SHOWING METHOD OF REVERSING POLARITY BY CAUSING THE LARGER FIELD TO DISCHARGE THROUGH THE SMALLER ONE

The alternator should be removed from the line and allowed to run idle with the exciter switch still closed. Build up the voltage by cutting out resistance in the exciter field, then quickly lower the exciter voltage by cutting the resistance back in again. This will duplicate the conditions under which the reversal originally occurred and the resulting reversal will bring things right again. The alternator, being disconnected from the line, will not be subjected to strain or current rushes. This method of restoring the original polarity, however, cannot be relied upon to produce reversal in cases where the exciter field is strongly saturated or has a natural time lag of current change comparable to that of the main alternator field.

The method to be followed here is the same as before—to cause the large field to discharge back through the smaller one. Allow the alternator to run idle as before—reduce the voltage of the exciter somewhat below normal, then quickly open the exciter armature circuit either by lifting one of the brushes of a small two-brush machine or by quickly disconnecting an armature lead loosened for the purpose. See point x in the accompanying diagram. This will remove the source of energy from the two fields. The decay of flux produces opposing emfs., but the alternator field overcomes the smaller and will cause enough current to flow to reverse the residual magnetism of the exciter.

MARKETING ELECTRICITY

A Department on Selling Service and Widening the Use of Electrical Energy

A Battery of "Wire-Your-Home" Inducements

How Premium Appliance Offers Were Used in the Campaign That Has Been Successfully Staged at Columbus, Ohio

The Columbus Railway, Power & Light Company has been developing its "Wire-Your-Home" campaign around the central idea of a premium offer of an electric appliance—selected by the customer—to every householder whose home was wired within the period of the campaign. At the same time two other special propositions were also featured.

On the one hand, a price of $24.71 for the complete wiring of a five-room house was widely heralded, while on the other, a special appliance sale placed a lot of additional energy-using devices in already-wired houses as well as in the newly-wired ones. The special premium inducement was at the same time opened up wider to induce the purchase of large appliances or an equipment of the smaller pieces, by offering various electrical devices free, thus putting still more energy-consuming utensils on the company's lines.

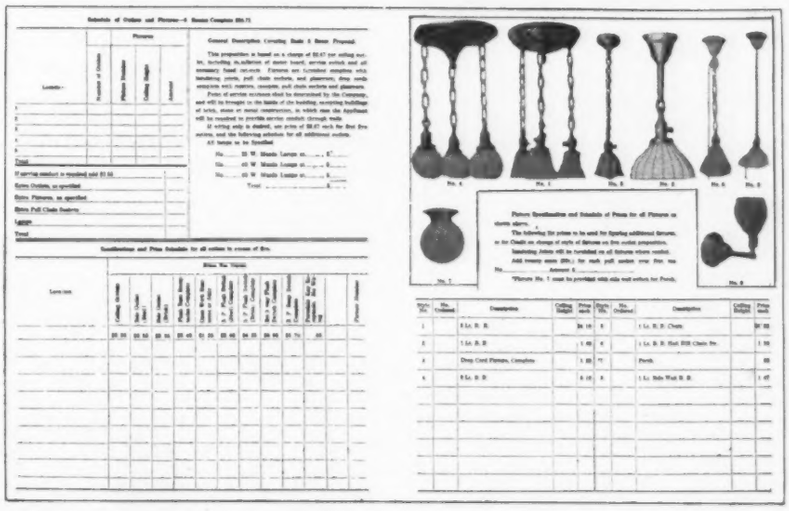
SPREADING THE STORY OF THE CAMPAIGN

Special newspaper display advertising, which preceded the sale, was supported by street car displays and numerous folders, and all the regular daily advertising for this campaign, were likewise fortified with folders which pictured styles of reading lamps, from which the new customer could select one as a free premium with his $24.71 order for house-wiring.

Free to You
Take Your Choice
5 Rooms wired complete with fixtures, ready for use—
24.71
You May Have One of the Following Premiums
BETTER COME IN TO SEE THESE

TABLE LAMPS, ELECTRIC HEATING APPLIANCES AND VACUUM BOTTLES WERE OFFEERED AS PREMIUMS TO HOUSE-WIRING CUSTOMERS

As a result the people of Columbus were greeted with a multiplicity of offers—certainly one of which was sure to make a strong appeal. All of the propositions, of course, led back to the main opportunity, the offer of a flat price on the wiring and fixtures for the unit



Special Sale
Electric Appliances
March 15th to April 15th, 1916
WE WILL GIVE FREE
With each Electric Washer purchased
One 7 cup Electric Coffee Percolator, or
One Electric Grill, or
One Quart Universal Vacuum Bottle, or
One Quart Universal Vacuum Carafe, or
One Electric Iron and One Electric Toaster.
With each Electric Cleaner purchased
One Electric Toaster, or
One 7 cup Electric Coffee Percolator, or
One Electric Grill, or
One Electric Iron, or
One Quart Universal Vacuum Bottle, or
One Quart Universal Vacuum Carafe.
With each purchase of Electric Appliances amounting to $12 or more
One Quart Universal Vacuum Bottle, or
One Quart Universal Vacuum Carafe.
This is our regular stock—prices remain the same
With each contract for wiring an already-built house, received during this time, we will give Free—
One Electric Toaster, or
One 7 cup Electric Coffee Percolator, or
One Electric Grill, or
One Electric Iron, or
One Portable Electric Stand Lamp, or
One Quart Universal Vacuum Bottle, or
One Quart Universal Vacuum Carafe.
5 ROOMS WIRED COMPLETE FOR $24.71

REPRODUCED ABOVE IS PART OF THE APPLICATION FORM MADE OUT BY THE HOUSE-WIRING CUSTOMER. AT THE RIGHT IS SHOWN A PAGE FROM A HOUSE-WIRING-MONTH BOOKLET DETAILING THE VARIOUS PREMIUM OFFERS

was used to call attention to the applinace sale and to the house-wiring offers. A special folder telling what was included in the house-wiring price of $24.71 and picturing the fixtures furnished and giving general information as to why the house should be wired and the cost of using electricity, was also widely distributed by the salesmen. Moreover, the meter readers left with each present customer another folder which gave the details of the premium offer. The fifteen additional salesmen in the field, working on the commission basis house, with an easy-payment offer that distributed the cost over ten monthly installments.

HOW THE CONTRACTORS GOT TOGETHER

In addition to these direct activities, the company enlisted the active co-operation of the electrical contractors in Columbus by agreeing to pay them cash for all wiring contracted for during the period of the campaign, regardless of who originally took the contract, and still allowing the new customer to pay the wiring

HERE IS THE PLAN
For $24.71 we will Wire Your Five Room House for Electric Lights
Complete With Fixtures, Ready For Use, in accordance with this schedule:
5 Ceiling Outlets at $2.67 ea. . . $13.35
Fixtures—Living Room No. 1 . . 4.10
Dining Room No. 2 . . 1.68
3 Bedrooms No. 3 at $1.25 each 3.69
7-40-watt Mazda Lamps at 27c ea. 1.89
Total 24.71
Outlets in Excess of Five
If the people who live in this little house can afford Electric Lights—
So Can You
Remember the Cost
$24.71
in Ten Monthly Payments
CALL US IMMEDIATELY
Let us send our Representative to see you

DETAILS OF THE FIVE-ROOM $24.71 WIRING OFFER AS REPRODUCED FROM A COMPANY ADVERTISEMENT

cost in equal installments over a period of ten months if he desires.

It is interesting to note in this connection that the Columbus Electrical Contractors' & Dealers' Association was organized on March 15, "for the purpose of securing closer co-operation and better understanding in the electrical industry, as well as to provide for the greatest possible development along these lines and to secure the mutual benefits which are usually to be derived from such an organization."

Sufficient newspaper space was used each day to present adequately the inducements of this special battery of "wire-your-home" offers, and 200 lineal feet of billboard space was contracted for and devoted exclusively to the house-wiring campaign, while during the final week a car was operated over the city's street car lines advertising the house-wiring and special appliance offers.

Success of Salary-Plus-Commission Plan of Paying Appliance Salesmen at Dayton and Toledo, Ohio

At Toledo and Dayton, Ohio, the appliance salesmen of the electric-lighting companies are paid salaries plus commissions. The salary is sufficient to make it profitable for the salesman to devote the necessary time to seeing that purchasers of devices are satisfied with them, while the commission serves as an additional incentive to sell the maximum number of energy-consuming devices. The straight salaries in these two cities differ slightly, being $40 a month at Dayton and $50 a month at Toledo. The commissions are as follows: Dayton—25 cents per energy-consuming outlet; 10 per cent on all appliances except flatirons, 50 cents on flatirons, 5 cents per outlet on signs, and 75 cents per motor horsepower contracted for. Toledo—25 cents per motor horsepower contracted for; $1 to $2.50 each on percolators, $2 to $4 on chafing dishes, $5 to $12 on vacuum cleaners, $10 to $20 on washing machines, and 50 cents on flatirons.

LARGE INCREASE IN THE DEMAND FOR VACUUM CLEANERS

As a result of this method of payment the appliance-sales business in Toledo has been increased from about $4,000 a year under the old plan of straight salary to $41,000 a year, with a sales force of only twelve men. Next year the appliance sales department contemplates doing $100,000 worth of business, as the commission is an incentive to overtime work. A large portion of the business referred to was derived from the sale of vacuum cleaners and washing machines, about 375 cleaners, 65 washing machines, 12 ranges, 1500 irons, 143 flag signs and numerous small appliances being sold.

As many as 400 house-wiring contracts a month have been secured in the same city on an installment plan in which the central-station company carries the accounts and allows extension of payments over ten months. Contractors do the wiring and are paid by the electric service company thirty days after completion of the work. Lately the experiment has been tried of letting the contractors handle the business alone, and only 200 to 250 contracts a month are being received. The reason given for this decrease is that the people favor doing business through the operating company, and another is that the contractors are reticent about shouldering the responsibility and consequently do not accept all of the contracts.

For these reasons, and also because their own salesmen are more likely to suggest providing additional baseboard outlets for various appliances, the central-station company intends re-adopting the old scheme of carrying the accounts. The salesmen will be paid $1 for securing such contracts. The average cost of wiring a residence, so far, has proved to be about $40 to $50 per dwelling.

Denver's "Mile-High" Electric Flag on the City's Tallest Building

Installed on the lofty tower of the Daniels & Fisher Building, Denver, this 14-ft.-by-9-ft. electric flag waves and flutters 300 ft. above the street, which is itself an even mile above sea-level. The flag can be seen for a distance of ten miles.

A House-Wiring Reminder for "Moving Day"—May First

Reproduced herewith is one of the advertisements which the Edison Electric Illuminating Company of Boston has been running in local newspapers this spring to remind prospective tenants and purchasers

A REMINDER TO THE MAN WHO EXPECTS TO MOVE MAY 1

of residence property that no house can be really modern unless it is equipped with electricity. The force of the reminder applies directly, of course, to the landlord and owner of unwired buildings no less than to the prospective occupants, and the result of this advertising has been the creating of a distinct sentiment to accept "nothing less" than a dwelling wired for electric service.

A "Book of Rules" Which Excited Interest in an Indiana House-Wiring Campaign

"In every campaign there are times when stimulation is needed to keep things moving," pointed out J. P. Ohmer, superintendent of the Indiana & Michigan Electric Company's Elkhart (Ind.) property, in discussing a recent house-wiring campaign in the course of which a so-called "book of rules" was used as an interest-enlivener with great success.

The "book" itself was a very simple little four-page folder, printed in red on buff-colored paper. Page 1 read: "Rule I. Never overlook an opportunity to make an investment that will net you a profit of 25 per cent. For particulars see page 4."

Page 2 read: "Rule II. Consult with Borneman & Sons (electrical contractors), who will save you 25 per cent on your house wiring and fixtures, co-operating with ——. See page 4." Page 3 read: "Rule III. Consult with Brice H. Reid & Company (electrical contractors), who will save you 25 per cent on your house wiring and fixtures, co-operating with ——. See page 4." Page 4 read: "Rule IV. Make it strictly electrical, Indiana & Michigan Electric Company." The books were inclosed in buff envelopes also labeled "Book of Rules" in red ink.

These interest stimulators were delivered to every residence in Elkhart, regardless of whether the occupant was or was not a user of electric service. The result was that everyone read them, if only out of curiosity. Then everyone was set to wondering and to talking about house wiring and about the Indiana & Michigan Electric Company and the contractors who were co-operating with it. The booklets delivered to customers cost the company 1.25 cents each, the deliveries being made by a force of youthful helpers directed by the company's solicitors, who, in light horse-drawn wagons, accompanied the delivery boys and carried the main stock of the booklets.

A Survey to Study the Use of Appliances at Cleveland

A quick canvass was made by the commercial department of the Cleveland Electric Illuminating Company a short time ago, to determine the use made of electrical appliances in Cleveland homes. The principal effort of the canvass was directed toward finding out the proportion of the appliances in the homes which were not in use, and also the cause for their not being used. Two principal reasons were looked for, namely: (1) appliances out of order, and (2) inconvenience of use, owing to lack of plugging facilities.

Forty district salesmen each made approximately thirty-five calls, totaling about 1400 homes visited. These homes were distributed over every section of the city, but were not in suburban districts.

From the homes having appliances the following data were obtained:

949 homes having appliances were visited.
1501 appliances were found.
1383 were in use, 92.2 per cent.
118 were not in use, 7.8 per cent.
52 appliances were found out of order—3.4 per cent.
8 were not used because base plugs were lacking.
58 were not used for miscellaneous reasons.

How the Dubuque (Iowa) Company Helps Find Tenants for Wired Dwellings

Since the first of the present year the Union Electric Company of Dubuque, Iowa, has been advertising for rent property in the city that is wired for electric light. Through one advertisement listing fifty pieces of prop-

FOR RENT
Property Wired for Electricity
WHEN YOU MOVE, RENT A WIRED HOUSE
It is not always easy to find just what you want when you move, so for your convenience we list below a number of homes that are equipped for Electric Light. More complete information we will gladly furnish without obligation or expense.
No. 1532 ALGONA AVENUE
Six room House. Fine place.
No. 126 ALTA VISTA STREET
Five room strictly modern lower Flat.
No. 10 SOUTH ALTA VISTA ST.
Seven room, new, strictly modern Lower Flat.
No. 209 BOOTH STREET
Six room house. Low Rental.
No. 7 CARDIFF STREET
Six Room Modern House.
No. 2718 COULER AVENUE
Four Room Cottage, a Bargain.
No. 2689 COULER AVENUE
Five Rooms, modern, $17.00.
27TH AND COULER AVENUE
Seven room, strictly modern, Lower Flat.
ARGYLE AND O'NEILL AVENUES
Seven Room Bungalow, new, $15.
No. 2544 ELM STREET
One-half Double House, a nice place for $12.00.
No. 521 WEST FIFTH STREET
New Six Room Modern Lower Flat
No. 332 MAIN STREET
Four Room Modern Flat, $14.00.
No. 16 RACE STREET
Seven Room Modern House.
No. 46 RACE STREET
Four Room Modern Upstairs Flat.
No. 256 SIXTH STREET
Modern Flat, Reasonable Rent.
No. 119 JEFFERSON STREET
Six Room Modern House Just Renovated.
No. 457 RHOMBERG AVENUE
Seven Room Upper Flat, $12.00.
The above is only a partial list of the vacant homes that are wired
IF you contemplate moving you may call our office, No. 700, and we will give more detail of the above as well as a number of other places we cannot list.
IF you have a vacant house that is wired, give in the details and we will include it in the next list we publish. There is no charge for this service.
TELL US WHAT YOU WANT, WE WILL TRY AND FIND IT FOR YOU
WE WANT YOU TO HAVE IT RENTED ALL THE TIME.
UNION ELECTRIC COMPANY
Telephone 700

KEEPING THE WIRED HOUSES RENTED AT DUBUQUE, IOWA

erty twelve houses were rented in one week. Besides securing twelve new customers for the company in the instance cited, such advertising insures the good-will of landlords and real estate men.

The Odorless Electric Vehicle—A Sales Point of Interest to Prospective Users Who Deliver Foodstuffs

The sales department of a large Western central-station company, in endeavoring to interest a bakery in the purchase of an electric vehicle, discovered that one of its strongest arguments lay in the fact that the electric vehicle eliminated the odor of burned gasoline. In the delivery of pies, cakes and pastry the presence of fumes of burned gasoline about the car is very undesirable, since the odor is absorbed by the butter in the pastry. It is said, therefore, that even if the gasoline vehicle could compare favorably with the electric in cost, the bakery man would favor the electric, since it allows him to deliver his product in better condition.

A Form of Contract for the Rental of Wiring Installations

Attention was called in these columns last week to the plan by which several Massachusetts companies have installed wiring in tenement dwellings under an arrangement by which the tenant or owner pays 15 per cent of the cost of the job as the annual rental of the installation.

As pointed out in that article (page 773, ELECTRICAL WORLD, April 1), of the 15 per cent rental charge 6 per cent represents interest and 9 per cent is allowed for depreciation, on an eleven-year basis. Reproduced herewith is the form of contract between owner, tenant and electric company which has been employed with success in these instances. The agreement provides that default in making the monthly payments shall constitute cause for the removal of the equipment.

Name..... *R. N*.....
Address..... *Date*.....191
.....Co.
.....(Address)
Dear Sirs:
Please wire my house, No.....Street,
and install fixtures, as follows:.....
.....
for which I agree to pay as rent the sum of.....
.....Dollars ($) per year, payable in equal monthly installments, as hereinafter provided; this amount being 15 per cent on an investment of Dollars ($) the sale price of the above property. This rental of 15 per cent per annum consists of two (2) charges, viz: 6 per cent per annum interest on the above investment, 9 per cent per annum depreciation on the value of the equipment.

I agree that a failure to object in writing to this equipment within a week after its installation shall constitute an approval of the work and materials thereof by me; in case of default in any monthly payment or sale of the property, you may enter, remove and repossess said equipment, retaining the same and all payments made as liquidated damages without further obligation or right on my part; and that I will not lease, mortgage or sell my house except subject to the terms hereof.

I agree, at my expense, to keep all said wiring and fixtures insured, to the full value thereof, for the benefit of said company.

I agree to pay for any damage or injury whatsoever which may occur to the buildings or property because of or due to the installation and use of the said wiring and fixtures by me.

.....Tenant
.....Owner
Accepted ..... Company
By.....

FORM OF AGREEMENT SIGNED BY TENANT OR OWNER PREPARATORY TO INSTALLATION OF WIRING RENTED HIM BY THE ELECTRIC-LIGHTING COMPANY

After one of these rental installations has been in service a short time, the owner is approached with the suggestion that he purchase the equipment and repay himself through a small increase in the monthly rent of the building. As a result many installations have been purchased outright in this manner, releasing the company's investment for other house-wiring work.

The Value of Residence Business to the Central Station[1]

By G. A. Lowther
Sandusky (Ohio) Gas & Electric Company

The value of residence business to the central-station company may be considered under three heads, namely, its value for revenue, its educational value, and its value from the investor's standpoint.

1. Residence revenue depends a great deal, I believe, on the way customers are "started off." If heating devices can be introduced when the residence is first connected, the small customer will produce good revenue from the first. It is easier to do this at the outset than to try and build up the load later on. Many central-station men have an idea that the only residences worth going after are the large ones in the best sections of the city, but this is a mistake. Last year we connected a number of small five- and six-room cottages. That they were not very large is evident from the fact that the cost of wiring was only a trifle over $30 each, and in most cases this included fixtures and lamps.

Surprising Monthly Use by Small Customers

When we started to go after this business the wiremen made sarcastic comments about "holding the shacks together" with their wires. The linemen evidently thought it was a waste of time and material to run services, and the meter men assured me that they would not need to read the meters because they would never use more than the minimum of 50 cents per month. But I recently checked up the records of more than 100 of these cottages and I found that they were using an average of more than 16 kw.-hr. each per month, that many were consuming more than 25 kw.-hr. per month, and some more than 30 kw.-hr. per month. I attribute these results largely to the fact that an electric iron was included with every wiring contract. The irons were not given away, but were figured in the contract price.

From the Standpoints of Public and Investor

2. Each new residence customer connected means the electrical education of the whole family. It may be that the availability of electric service starts the head of the family thinking of ways to use electricity in his business, or it may be that it starts other members of the family thinking along electrical lines; it may lead to the introduction of electric service in places where members of the family work, and it nearly always leads to further electrical development in the neighborhood or among the friends of the household.

3. I have been informed on good authority that the central station which has a large residence-service load finds it much easier to get money for securities from bankers and investors than the central station which can only show a large power load. The inference is, of course, that the residence load remains, no matter what happens, whereas the power load is likely to be less dependable. It would therefore seem that residence business also has a real value from the investor's point of view.

[1]Abstract of paper read at Springfield meeting of commercial men of Ohio Electric Light Association.

ADVANCE IN TECHNICAL THEORY AND PRACTICE

Including a Digest of Important Articles Appearing in the Scientific and Engineering Press of the World

Characteristics of the Tungsten Arc

Newly-Discovered Facts Concerning Arcs Between Non-Vaporizing Electrodes Necessitate the Formation of New Conceptions on the Production of an Arc

THE tungsten arc has lately attracted much attention both in this country and in England. It is too early yet to say what its commercial importance may be in future, but not too early to call attention to the far-reaching changes which the operation of the tungsten arc seems to necessitate in our notions of the way in which an arc is formed. This point has been brought out in an investigation carried out in the research laboratories of the General Electric Company and reported by G. M. J. Mackay and C. V. Ferguson in the February issue of the *Journal of the Franklin Institute.*

FIG. 1

A typical tungsten arc lamp is shown in Fig. 1. In order to study the effect of temperature at the cathode this electrode is supplied with a tungsten filament requiring about 20 amp. to heat it to 2800 deg. K. The anode is made large so that it will operate at a comparatively low temperature. Fig. 2 shows the volt-ampere characteristic of hydrogen as found on direct current with such an arrangement. It will be seen that it has the typical form, showing an unstable portion at *A*, where the discharge changes with increasing current from an almost invisible glow to a very concentrated arc discharge, and a less noticeable "kink" at *B*. Other gases, such as nitrogen and argon, however, do not show such well-defined points of instability. The appearance of this arc is very striking, and though very thin and of little luminosity, the path is very clearly defined. The energy consumption is also very high, due doubtless to the fact of its more or less complete disassociation into atoms at the temperature involved, and its extremely good thermal conductivity. Thus the arc of Fig. 2, 1 mm. long and 0.5 mm. in diameter, consumes 700 watts, operating at 25 amp. and 28 volts. It should be a very good source of ultra-violet radiation.

If the characteristics of the arc are affected to any extent by the evaporation of electrode material, as has been supposed with carbon and low boiling-point metal electrodes, where the vapor pressure of the substance often reaches atmospheric pressure, it should be expected that strikingly different results would be obtained with the tungsten arc. Since such differences have not been found, and since many arcs have shown no spectroscopic evidence of the presence of tungsten in the arc stream, it would appear that rapid evaporation plays no necessary part in the conduction of current.

On direct current the nature of the anode, whether large or small, of copper, carbon or iron, does not appreciably affect the electrical characteristics. The most interesting and most important phenomena occur at the cathode, which may take the form of a filament as shown above, capable of being heated to various temperatures by an external source of energy. In order for a discharge to have the typical "falling" volt-ampere characteristic shown in Fig. 2, it is necessary that the cathode spot be heated to a comparatively high temperature, approximately 2800 deg. K, either by the application of energy from without or by bombardment of positive ions from the gas. The chief function of a cathode heated from an external supply is the great reduction in sparking or arcing potential, which enables the discharge to be started at a voltage relatively very low in comparison with that necessary between cold electrodes. For instance, an arc in hydrogen with a 1-mm. gap will start on 400 volts if the cathode be heated, whereas with a cold electrode a voltage in the neighborhood of 4000 is required. Once the arc has started, the exciting current may be shut off from the filament, when the discharge will run with very little increase in voltage and maintain its own cathode spot at the proper temperature. The tungsten button in Fig. 1 offers a good design for this purpose, since the "spot" may be removed from the more fragile filament. With lower pressures, of course, much less voltage will start the arc over much wider gaps, and hence the bringing of the electrodes together to strike an arc is obviated and the advantage of a fixed gap length secured.

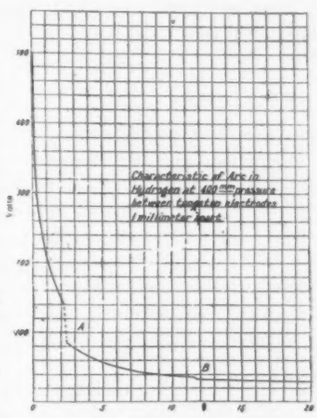


FIG. 2—VOLT-AMPERE CHARACTERISTICS OF HYDROGEN ON DIRECT CURRENT

Fig. 3a illustrates these characteristics very well when an arc on alternating current is maintained between a tungsten cathode small enough to be kept hot by the discharge and an anode large enough to operate at a much lower temperature. These wave shapes were determined by oscillograph in argon at 20 cm. pressure. They show how the voltage necessary to start the arc from the hot cathode is no greater than the arc drop itself, whereas on the other half of the cycle, though there is a slight current from the beginning, the anode does not act like the hot cathode until the voltage has reached the peak of the wave. As the anode is allowed to heat, however, this "arcing back" voltage gradually decreases. This current obtained at the beginning of the half cycle when the large electrode is negative is probably due to persistence of the ionization produced during the first half of the wave. It is in sharp contrast to the complete rectification shown in Fig. 3b, where the rise of poten-

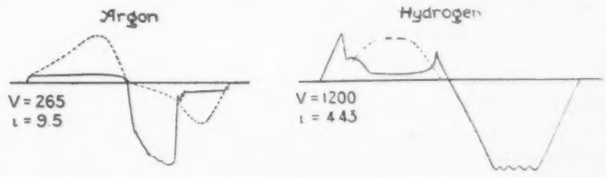


FIG. 3—RECTIFICATION CHARACTERISTICS (*a*) IN ARGON AND (*b*) IN HYDROGEN

tial at the end of the cycle and the sharp "cut-off" indicate a rapid recombination of ions due to their greater rate of diffusion in hydrogen. In an atmosphere of nitrogen or air there is a chemical reaction occurring between electrodes and the gas. It has been thought by some that chemical reaction aids materially in the formation of an arc, but in these cases such conditions are certainly much less favorable than with the "inert" gases, argon and hydrogen.

It would, therefore, appear that rapid vaporization and chemical reaction at the electrode surfaces are merely incidental to the physical phenomena involved, which are undoubtedly the most important. Effects which must be considered are: (1) thermionic emission from the hot cathode, (2) thermionic emission from the hot gases, (3) effect of temperature on the gas to increase the kinetic energy of the molecules so that ionization may be produced by impact as suggested by J. J. Thomson, and (4) secondary electron emission from the hot cathode due to bombardment by positive ions.

Generators, Motors and Transformers

Determining the Transformation Ratio of Transformers.—PESTARINI.—An illustrated description of a method for which high accuracy is claimed and which is independent of the variation of the voltage of the supply circuit. It is a zero method, very much like a potentiometer method, and requires a graded resistance box and an instrument for detecting alternating current to determine zero current.—*La Lumiere Elec.*, Jan. 8, 1916.

10,000-*Volt Direct-Current Generator.*—W. LINKE.—A rather full translation in abstract of his German paper noticed some time ago in the Digest on a direct-current generator for 10,000 volts supplied by a German company to the Reichsanstalt for scientific purposes.—London *Electrician*, March 17, 1916.

Lamps and Lighting

Recent Progress in Industrial Lighting.—L. GASTER.—An abstract of a paper read before the British Association of Supervising Engineers. The watts per candle have diminished from 5 for carbon filaments to 1.25 for tungsten to 0.65 for tungsten "arc incandescent," the "intrinsic brilliancy" or candle-power per square inch has increased from 381 for carbon to 12,900 for tungsten arc. The method for rating lamps was dealt with and it was suggested that mean spherical candle-power should be indicated by lamp makers. By means of the "holophane lumeter" measurements can easily be made. With modern lamps roughly 1 cp. per square foot produces an effective illumination of 3 ft. candles, when the lamps are arranged according to the uniformly distributed overhead system, with mounting heights ranging from 12 ft. to 16 ft. above the floor, and when the light is directed from the lamps in an efficient manner. Reflectors should screen the source of light from the worker's eyes, distribute the light where it is most needed and diffuse the light. There is strong connection in factories between number of accidents and lighting methods. Inadequate illumination restricts the output and leads to spoiled work, and where expensive labor is employed it pays to illuminate well. The present tendency seems to be toward using incandescent lamps of moderate candle-power, 300 or so, instead of 1000, and in this way the lighting is subdivided, and better conditions regarding shadows are obtained. Special attention should also be paid to the provision of light walls and ceilings. Dust deposits on lamps and reflectors may reduce the illumination in a factory by 50 per cent.—London *Electrician*, March 10, 1916.

Projectors and Reflectors for Domestic and Street Lighting.—HAYDN HARRISON.—A report of a paper on the efficiency of projectors and reflectors before the Liverpool Engineering Society. The author explained the reason for the increased efficiency of searchlights using lamps on the Beck principle; he also advocated the use of highly concentrating reflectors with diffusing globes for domestic lighting, and contended that lamps with similar reflectors on high posts, far apart, for street lighting would be as efficient as the present methods using flame arcs, and would only require about one-fifth the electric power.—London *Elec. Eng'ing*, March 2, 1916.

Rating of Incandescent Lamps.—F. W. WILLCOX.—The writer points out that rating by watts is primarily a size rating to give a convenient, even and fixed set of values by which lamps can be sized and regularly listed and supplied uniform with the fixed sizing in total watts of other electrical appliances, such as heating appliances, transformers, meters, etc. For measuring luminous output the tendency is growing now to use the lumen rather than the candle-power and this is strongly recommended.—London *Electrician*, March 10, 1916.

Low-Voltage-Lamp Lighting System.—A note on a British patent (5768, 1915) of I. Frankenburg & Sons, Ltd., and R. Fleming for a system of low-voltage lighting, which consists in placing in a high-voltage circuit an auxiliary resistance, such as one or more high-voltage lamps in parallel with a number of low-voltage lamps in series, each small lamp being provided with a small shunt resistance.—London *Elec. Eng'ing*, March 2, 1916.

Traction

Electric Traction on French Railway.—J. REYVAL.—Since December, 1914, the French railway company Du Midi is operating electrically its lines from Tarbes to Bagneres-de-Bigrove (22 km. or 13 miles) and from Lourdes to Pierrefitte (21 km.). During the first year the operation has been regular and perfectly satisfactory. The single-phase system is used. Single-phase current at 60,000 volts and 16 2/3 periods is supplied from the hydroelectric station at Soulorn, near Pierrefitte, and the voltage is reduced to 12,000 in the substations of Lourdes and Tarbes; the trolley voltage is 12,000; the rails are used as return circuit.—*La Lumiere Elec.*, Jan. 8, 1916.

Direct-Current for Terminal and Trunk-Line Electrification.—NORMAN WILSON STORER.—The first part of a long illustrated abstract of a paper read before the (British) Institution of Electrical Engineers. The paper discusses the series motor, acceleration, and questions of control. Regenerative systems are considered, as well as the question of voltage and interchangeability—London *Electrician*, March 17, 1916.

London Tramways.—An abstract of the annual report for 1914 of the London County Council Tramways. The total length of the Council's tramways on Jan. 1, 1914, was 147 route-miles, and on Dec. 31, 1914, it was 149½ route-miles, of which about 143½ miles were electric tramways. During the year 1914 nearly 60,000,000 miles were run by the Council's tramcars, while nearly 535,000,000 passengers were carried. Data are given on extensions, generating stations and fares. The total working expenses, exclusive of capital charges, were 13.42 cents per car-mile (against 13 cents in the preceding year). The total revenue per car-mile was 19.36 cents (against 18.42 cents). The war service allowance caused a deficiency of $166,000, which was met out of the general reserve fund. But for this there would have been a surplus of $45,000. Tests were made of petrol-electric cars on the Tooley Street to Greenwich Church route, but as the experiment did not prove satisfactory

they were withdrawn from service. It has now been decided to use them as tractors of trail cars between the main tramway routes and the depots in which the trail cars will be housed.—London *Electrician*, March 17, 1916.

Installations, Systems and Appliances

Oil Switches.—BRUNO BAUER.—The first report of the commission on high-tension apparatus and fire protection appointed by the Swiss Electrical Society and the Association of Swiss Central Stations. The conditions are investigated theoretically for the maintenance of an electric arc in an oil switch. In order that an arc may exist two conditions must be fulfilled: the voltage must be above a certain minimum value, and the power must be above a certain minimum value. These two conditions are investigated mathematically. The heat generated at the contacts of an oil switch is not

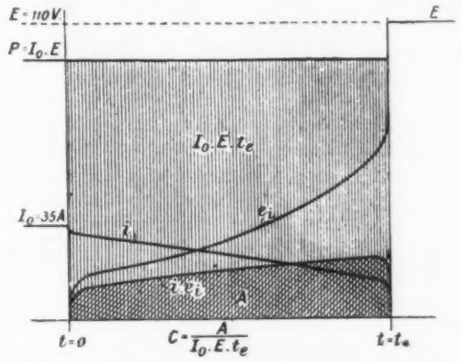


FIG. 4—CURVES SHOWING GRADUAL DECREASE OF CURRENT AS SWITCH VOLTAGE RISES

equal to the total energy flow that is interrupted. Considering the case of a continuous-current load, *i.e.*, the current may be considered to decrease gradually as the switch voltage e_i rises according to the assumed curves of Fig. 4. The curve $e_i i$ shows the variation of the power in the arc, and it will be noted that this power has a finite value at the moment of interruption. In the case of an alternating current load the interruption takes place near to the point of zero current, and on this account the strain on the switch is much less severe than in the case of a continuous-current load. The doubly-shaded area A represents the energy transformed into heat at the switch, and this bears to the total energy that would pass in the circuit during a time equal to the switching period a ratio C. We have thus $A = CI_0Et_e$, when C is a constant of the switch and t_e the time in seconds. At a frequency of 50 cycles a second C is found to vary in modern oil switches between 0.02 and 0.07 and for continuous current to reach a value of 0.18. Tests were made in the power station of Beznau with one of the 1000-kw., 8000-volt, 50-cycle generators installed there operating on a water load. Oscillograms were taken of the current, arc and line voltage and the length of the switch opening, the latter being determined by a mechanical attachment to the switch blade designed to actuate one of the oscillograph movements giving it a deviation proportional to the distance traversed by the switch contact. The main object of the tests was the determination of the quantities C and t_e and as C varies for a given form of contact between much narrower limits than t_e, it is the value of t_e that has by far the greater importance in estimating the capacity of a switch. It is found that under normal conditions C is constant. The results of numerous tests are given in tables. A series of tests at 8000 volts and non-inductive loads from 200 kw. to 800 kw. with switch velocity 55 cm./sec. gave as mean values 1 cp. — 5.6, y = 98, C = 2.8 per cent. Even in the extreme case of short-circuits on large units C does not exceed 5 to 7 per cent. The way in which the time t_e depends on the power, voltage, etc., is investigated in great detail mathematically and the results of these investigations are given in tables and diagrams and experimental confirmations of the theory are also given. One of the results obtained is that the length of arc and the switch energy depend not only on the magnitude of the load and the constants of the switch, but also on the constants of the generating plant. For a given load the switch energy increases with the reactance of the generator. This effect is most marked with heavy loads. The length of arc and the switch energy decrease the greater the number of generators running in parallel. If the load is inductive and constant in value, the phase displacement in the mains is added to the displacement produced by the internal reactance of the generator, so as to cause the switch energy to increase rapidly with the external phase displacement. It is more dangerous to switch off a load from a generator of poor regulation than from one of close regulation. This is contrary to the accepted opinion of switch designers, who consider that a large drop of voltage in the generator assists the interruption of the load current. This point is of particular importance in connection with the switching off of short-circuits. For the smallest switch energy to be developed both the switch contacts should be made of copper (brass and iron giving far worse results); the usual commercial forms of contacts do not show any marked difference in respect to the switch energy developed; diminishing the mass of the contacts tends to increase the switch energy, but increase of mass above that usually employed does not lead to any marked improvement; the contact area should be not too small and well-rounded off, as points and edges become a seat of negative arc craters, and thus increase the voltage across the switch.—London *Electrician*, March 3, 1916.

Starting and Controlling Apparatus.—C. C. GARRARD.—An illustrated article in which the author describes the design of variable resistances which enable electric motors to be started up without taking an excessive current from the mains and without mechanical shock, and also enable the running speed of the motors to be varied at will. The author first deals with direct-current motor starters and describes the method of grading direct-current starter resistances. He then deals with the choice of starters for squirrel-cage motors and describes first the use of auto-transformer starters for squirrel-cage motors. The rating of auto-transformer starters and the choice of the number of tappings on auto-transformer starters are discussed.

A continuation of his serial on apparatus for starting and controlling electrical running machinery. The discussion of the choice of type of a starter for a squirrel-cage induction motor is finished and the following conclusions are reached. The resistance type of starter for squirrel-cage motors should very rarely be used. Its only advantage is that it can easily be made with no-volt and overload releases, and thus for small sizes may sometimes find application. For motors up to 25 hp., and occasionally for larger sizes, where the motor is started up light—*e.g.*, when it is connected by a clutch or loose pulley to its load, or where it only has to start up short lengths of shafting—the star-delta switch is best. When the starting conditions are severe, or unknown, or when the local or supply authority places restrictions on the value of the sudden starting current, then auto-transformers afford the best solution. The author then begins the discussion of the starting and speed control of three-phase slip-ring induction motors.—London *Electrician*, March 3 and March 17, 1916.

Moscow.—J. BICHNIAK.—A review of the gradual developments of the electricity supply for light, power and traction purposes, in Moscow since 1886. The maximum capacity of the station is 80,000 kw. Some notes are added on the cable distribution system.—*La Revue Elec.*, Feb. 4, 1916.

Oil Switches.—An illustrated description of various types of oil switches designed by a German company.—*Elek. Zeit.*, Feb. 24, 1916.

Electrophysics and Magnetism

Unipolar Induction and Absolute Rotation.—E. H. KENNARD.—A brief abstract of an American Physical Society paper. In order to fill out some gaps in the experimental evidence bearing on the problem of unipolar induction, an apparatus has been constructed consisting of a cylindrical condenser inside a solenoid, both condenser and solenoid being capable of independent rotation about their common longitudinal axis. The inner coating of the condenser is connected, by means of a needle dipping into mercury held in an insulated cup, to one pair of quadrants of an electrometer, the other pair being earthed; the outer coating of the condenser connects through the bearings to the frame of the apparatus and so to earth. Let the condenser be set in rotation and let the solenoid be magnetized. Then, according to the theory of Lorentz, an electromotive force will be developed in all rotating radial parts of the apparatus; thus a difference of potential should be set up between the coatings of the condenser and the electrometer should show a deflection. Furthermore, the effect should be quite independent of the rotation of the solenoid. Preliminary observations already obtained show the existence of an effect of the right order of magnitude and in the right direction. Simultaneous rotation of the solenoid has no effect. Undoubtedly the most interesting case is when the condenser and solenoid are locked together and set in rotation; change of the magnetic field results in about the same deflection as if only the condenser were rotating. If we admit that the simultaneous rotation of the axial connecting wires, the electrometer, the room and the fixed stars would not alter the effect, as seems most likely to be true, then we may say that with the present apparatus a purely electromagnetic effect which is due to absolute rotation has actually been observed.—*Phys. Rev.*, March, 1916.

Corona.—EARLE H. WARNER.—A brief abstract of an American Physical Society paper on a new law relating to ionization pressure and current in the corona of constant potentials. The "corona" is the glow which surrounds conductors when there exist high potential differences between them and neighboring conductors. Farwell has shown that at the instant the corona appears the pressure in the corona apparatus increases. The object of the author's experiments was to test the relationship between the ionization pressure and corona current. The corona apparatus was of the wire and coaxial-cylinder type. The continuous potential was obtained from a battery of forty continuous-current, shunt-wound, 500-volt generators connected in series. The corona current was measured with a D'Arsonval galvanometer. The increase in pressure was measured by a Bristol aneroid pressure meter. Experiments were performed with dry air, hydrogen and nitrogen in the corona tube. In every case, with the wire positive, the ionization pressure is exactly proportional to the corona current. With the beads, which accompany the negative wire, the pressure varies with the arrangement of the beads and since these are not stable it is impossible to determine accurately the desired relationship.—*Phys. Rev.*, March, 1916.

Miscellaneous

Russian Electrical Market.—P. GUREVITCH.—A long translation in abstract of an article published in the Russian journal *Elektrichestvo*. The German importation of electrical goods into Russia had grown from $3,500,000 in 1909 to $8,500,000 in 1913. But the war has forced Russian importers to turn for such goods to other countries, particularly England. "Unfortunately, however, while Russian buyers, faced with the necessity of filling up the blank that has been formed, are greatly interested in English goods, the English electrotechnical industry—with a few exceptions—does not feel any special need of new markets, and, therefore, has not shown any particular interest in the Russian market." The different branches of the electrical industries are discussed with respect to manufacture in Great Britain and market in Russia. It is pointed out that "the Russian market for English manufacturers of dynamo machines and electromotors was not an important one before the war. While Germany sent in 1913 into Russia 12.6 per cent of all her export of electrical machines, totaling, with armatures and commutators, $1,970,000 England sent into Russia only 2.7 per cent of its total export of these machines. Even Switzerland exported these machines to Russia to twice as great an extent as England. Germany, on the other hand, exported six and a half times as many as England. Meantime, dynamo machines and electro-motors happen to be that department in which England previous to the war could compete more or less successfully with Germany on the Russian market." It is emphasized that in the United States the question of seizing the South American markets is now greatly considered. The exportation of electrotechnical goods from the United States has considerably increased recently. The United States can become a large provider of electrotechnical goods in the future on the Russian market. "Whether Germany or the United States obtains the South American market is all one.

Undoubtedly the suffering factor after the war will be the English electrotechnical industry. It therefore should, in order to fill up the blank from the reduced exportation to South America, seek new markets, and one of such markets, presuming sufficient enterprise on the part of the English, should be Russia. One of the hindrances to the extension of the export from England to Russia, as has been frequently shown in the Russian economic press, has been the unwillingness of the English to give credit." Unfortunately, Russia's business people have abroad in respect to payments a very bad reputation. "If, however, foreign providers were to make distinctions between various trading firms and factories, etc., in all probability their losses would be less. Most of the insolvencies in Russia fall to trading concerns, while insolvencies in the factories are relatively few, for in Russia large concerns prevail." A long editorial deals with the same subject. It is said that British manufacturers will require to know more about the Russian government's policy for excluding German electrical manufacturers. "The Russian government is not likely to deprive German traders of facilities if by so doing it is going to affect adversely Russian developments; therefore, it is not unlikely that it will want to know something about British Allied and neutral manufacturing capacity. The situation is not an easy one to deal with, but the details will inevitably hang very largely upon the broad principles which are adopted by the trade conference of the Allies."—London *Elec. Review*, Feb. 25, 1916.

Holland—Statistical tables showing importations of electrical goods into Holland for 1913 and 1914.—London *Elec. Review*, Feb. 25, 1916.

Trial Installations of Concentric Wire and Fittings

To the Editor of ELECTRICAL WORLD:

SIR: I note in the issue of the ELECTRICAL WORLD of March 18 an article accredited to R. S. Hale of the Boston Edison company in which he states that the undersigned indorses the use of concentric wiring equipments. I am without any knowledge as to Mr. Hale's source of information, but I wish to assure you that the statement is absolutely incorrect. I would ask that you be good enough to give my denial as much publicity as was given to the article to which I refer.

WASHINGTON DEVEREUX.

Philadelphia, Pa.

To the Editor of ELECTRICAL WORLD:

SIR: In the March 18 issue of the ELECTRICAL WORLD R. S. Hale is reported as having stated that the use of concentric wiring would be recommended and approved by the writer. I assume that Mr. Hale has been correctly quoted, and desire to correct the statement which has been made. No authority was ever given to Mr. Hale or any one else to the effect as stated. Kindly give this statement as much publicity as Mr. Hale's article received and thereby oblige, J. C. FORSYTH,

New York Board of Fire Underwriters.

New York.

To the Editor of ELECTRICAL WORLD:

SIR: I have just noticed in your issue of March 18, on page 676, a report of a statement of R. S. Hale of the Boston Edison company made at a convention of the New England Section of the National Electric Light Association headed "Future of Concentric Wiring Here Depends on Central Stations," in which the statement is made that I "approve the use of this material," referring, of course, to the concentric wiring now in experimental use.

I must assume that Mr. Hale was correctly reported, and if this is the fact I am wondering whether his statistics regarding the conditions surrounding concentric wiring abroad are as reliable as the statement regarding my approval above quoted, which statement is absolutely without foundation and fact, and is made without any authority from me, either verbal or written.

As a member of one or two of the committees which have been considering this whole subject for the past year or more, I have endeavored to keep my mind open until the material in question has had a proper trial, but I must say that a personal inspection made of one of the three trial installations in Boston, which it is said was installed by the most expert workmen in the city, has rendered it more difficult for me to retain this much-desired condition of open mind.

I will consider it a favor if you will give this letter the same publicity as was given Mr. Hale's statement above mentioned. JAMES R. STRONG,

Tucker Electrical Construction Company.

New York.

Readers' Views and Comments

To the Editor of ELECTRICAL WORLD:

SIR: My attention has been called to Mr. Strong's letter and to the report of the Question Box convention of the New England Section of the National Electric Light Association.

Mr. Strong is incorrect in assuming that I was correctly reported. As a matter of fact, I made no reference to him at all.

One of the speakers from the floor suggested that if any wiring contractor or central station should have any difficulty in obtaining permission from the local underwriters or local inspectors to make an experimental or field installation of concentric wire that they should show to the inspector the report of the sub-committee on concentric wire which was unanimously signed by J. G. Forsyth, Washington Devereux, Dana Pierce, A. M. Paddon, G. S. Lawler, James R. Strong, H. R. Sargent and W. H. Blood, Jr.

It seems to me that what is now wanted is field and practical experience rather than theoretical discussions or what might or might not happen under unusual conditions.

I understand the wire and fittings are now nearly ready for shipment, and I trust that no difficulties are going to be placed in the way of obtaining the practical experience which is the only real test of the value of the system.

R. S. HALE, *Chairman,*

Committee on Wiring,

National Electric Light Association.

Boston, Mass.

To the Editor of ELECTRICAL WORLD:

SIR: In your issue of March 18, page 676, appears a report of remarks of R. S. Hale and myself upon the concentric wiring situation, which was discussed at the recent Question Box convention of the New England Section of the National Electric Light Association. From this report the inference may be drawn that Messrs. J. C. Forsyth, Washington Devereux, Dana Pierce, A. M. Paddon, George S. Lawler, James R. Strong, H. R. Sargent and W. H. Blood, Jr., approve the use of concentric wiring. I think this statement is a little too strong. In speaking upon this subject at the convention, I stated, in answer to inquiries from the floor, that if any central station found difficulty in securing permission to make an experimental installation of this material, it would be a good plan to call the attention of the local inspector or insurance authorities to the tentative set of rules for concentric wiring prepared by these gentlemen, who are members of a sub-committee of the electrical committee of the National Fire Protection Association.

There was no intention of conveying the idea that the sub-committee had approved the use of this material which is simply being tried out at this time for experimental purposes under very close supervision.

It was, I believe, the feeling of this committee that if concentric wiring was to be installed the manufacturers and the contractors should have some suggestions as to how the wire should be made and how it should be installed. As a result the committee prepared a set of rules for consideration. These rules were presented to the electrical committee and "no action" was taken in reference to them. This is the only action ever taken by the committee, and it should not necessarily be considered, I believe, as an indication of approval of the concentric wiring system by the individuals composing the committee.

Personally, I am strongly in favor of concentric wiring, and believe that when it is properly installed it is safer, better looking and possibly cheaper than some other forms of construction. I do not make any claim to speak for the other members of the committee.

W. H. BLOOD, JR.,

Insurance Expert,

National Electric Light Association.

Boston, Mass.

Saving the Discharge from Boiler Blow-Off

To the Editor of ELECTRICAL WORLD:

SIR: As a general rule, the water that is discharged from the blow-off pipe of a boiler during the operation of blowing down is led to the sewer and allowed to run to waste. It carries with it dissolved salts, sediment, and some particles of scale that have become loosened from the water surfaces, and therefore it is not fit to be used again immediately as feed water. In some instances, however, it may be advisable to reclaim the blow-off discharge and to pump it back into the boilers.

Such a procedure, of course, involves the separation of the water from the scale and sediment that it carries, which is accomplished by filtering. A good way to do this is to discharge the blow-off water into one end of a tank that is fitted at the middle with a charcoal filter through which the water passes to the other end. The impurities will be retained by the filter and the water may then be pumped through the feed-water heater back into the boilers.

The tank, which may be constructed of concrete, should be of large capacity, so that a considerable quantity of feed water may be stored, ready to be used in case other sources of supply are inadequate or fail altogether. In a locality where an ample supply of suitable feed water is available at little expense, it would serve no useful purpose to save the blow-off discharge; but if water fit to be fed to the boilers is expensive, or if the supply is likely to fail unexpectedly, the cost of a filtering blow-off tank and storage may be fully warranted.

S. U. TUSPIN.

Scranton, Pa.

A. W. HIGGINS

Men of the Industry

Changes in Personnel and Position—Biographical Notes

Albert W. Higgins, the new general manager of the Merchants' Heat & Light Company of Indianapolis, Ind., is a graduate of the Massachusetts Institute of Technology's course in chemical engineering, class of 1901, and had his first engineering experience in the chemical industry. In 1904, however, he entered the engineering and contracting business, building power plants, electric railways, water works, underground conduit systems, etc. From 1910 until 1913 Mr. Higgins acted as fuel engineer for several large Eastern and Western coal-mining companies, and in the year last mentioned became associated with the Kelsey-Brewer interests in the operation of the La Cross (Wis.) property as superintendent, subsequently being appointed general manager. After completing the rehabilitation of this property, Mr. Higgins was transferred to the Merchants' Heat & Light Company as general manager in charge of construction and operation.

W. S. Hill has been appointed superintendent of the commercial department of the Springfield (Mo.) Gas & Electric Company, succeeding R. S. Gallagher, who was recently appointed commercial manager at Hot Springs, Ark. Both the Hot Springs and Springfield properties are operated by the Federal Light & Traction Company.

W. E. Skinner, recently of Winnipeg, Canada, has opened an office as consulting engineer, at 415 Plymouth Building, Minneapolis, Minn. Mr. Skinner entered the employ of the Westinghouse Electric & Manufacturing Company in 1891, and after six years at East Pittsburgh, Pa., he went to the sales office at Buffalo. In 1900 he was transferred to Honolulu, Hawaii, where he acted as consulting engineer for the Hawaiian Electric Company. In 1904 he joined the organization of the Canadian Westinghouse Company, Ltd., at Hamilton, Ont. While there he opened the company's Winnipeg office, and remained in charge until 1907, when he opened an engineering office in Winnipeg under the firm name of W. E. Skinner, Ltd., of which he was president. In addition to work for many corporations, cities and towns, Mr. Skinner has also for two years acted in a consulting capacity to the public utilities commissioner of Manitoba.

J. E. Hillemeyer has been appointed superintendent of distribution of the Electric Company of Missouri, succeeding S. H. Wallace.

Hans J. Gerlich, sales office manager of the Flatbush Gas Company, which is a combination gas and electric corporation of Brooklyn, N. Y., has been elected president of the newly-organized Flatbush Chamber of Commerce.

A. W. Malone has been appointed superintendent of construction of the 130,000-volt transmission line now being built by the Utah Power & Light Company over Soldiers' Summit and through the towns of Helper and Price, Utah.

Ferd J. Derge, chief engineer for Henry L. Doherty & Company, has returned to his office in Toledo, Ohio, after an absence from work of several months owing to illness. During the period of recuperation Mr. Derge took a sea trip to Panama, and has now thoroughly recovered his health.

W. M. Lewis, district manager of the Consumers' Power Company at Muskegon, Mich., has been elected first vice-president of the Muskegon Chamber of Commerce and a director of the Century Club of Muskegon. Mr. Lewis has been a resident of Muskegon about two years, having come there from Rockville, Conn., where he was formerly president of the Chamber of Commerce.

E. H. Le Tourneau has been appointed efficiency engineer of the Portland Railway, Light & Power Company, Portland, Ore., to succeed Edward A. West. Mr. Le Tourneau recently held the position of assistant engineer in the office of O. B. Coldwell, general superintendent of the company. He has been with the company for the last six years in various capacities.

J. M. Rodger has been appointed Cleveland representative of the business department of the ELECTRICAL WORLD, with offices in the Leader-News Building of that city. Mr. Rodger was until recently a member of the Chicago office staff, and prior thereto was associated with the Union Electric Light & Power Company, the G. I. Lamp Company, and the Duplex Metals Company.

Frank A. Vanderlip, president of the National City Bank, New York, and Pierre S. du Pont, president of the E. I. du Pont de Nemours Powder Company, Wilmington, Del., have been elected life members of the corporation of the Massachusetts Institute of Technology. Dr. Samuel J. Mixter, Boston, Mass., and Messrs. Harry J. Carlson, Newton, Mass., and Henry J. Horn, Brookline, Mass., have been elected members of the corporation for a five-year term.

PHILIP TORCHIO

Philip Torchio, chief electrical engineer of the New York Edison Company, who contributes to this issue an article on a method of construction of high-tension cable joints, was born at Vercana, Province of Como, Italy, in 1868. Graduating from a course in mathematics and physics at the University of Pavia in 1890, he took up mechanical engineering at the University of Milan, also completing during the last year of his residence there a course in electrical engineering at the Institute Carlo Erba. Coming to the United States in 1893 he served for a number of months with the Sprague Electric Elevator Company, but in 1895 he joined the New York Edison organization, with which he has been connected ever since. Mr. Torchio has been closely identified with the development of the extensive alternating-current system of the New York company. He was also responsible for the introduction of the thin-plate storage battery for central-station standby service. He has obtained patents on ground and fault detectors, insulating coverings for cables, circuit breakers, reactance coils and protective devices for busbars and cable joints. Mr. Torchio is a member of many engineering societies, both here and abroad, and has presented before their meetings numerous papers and discussions covering a wide range of electrical engineering topics.

Frank Espy, who has been manager of the northern division of the Ohio Light & Power Company with headquarters at Tiffin, Ohio, has been appointed general manager of both the northern and southern divisions of the company, with headquarters at Newark. Mr. Espy succeeds H. L. Montgomery, who has been appointed manager of the Atlantic City (N. J.) Electric Company.

Obituary

Charles Fowler Baldwin, formerly chief engineer for the Western Electric Company at Antwerp and London, and for nineteen years a member of the company's engineering department, died at Pittsburgh, Pa., April 9. Mr. Baldwin was buried at Montclair, N. J., of which city he was a resident.

NEW APPARATUS AND APPLIANCES

A Record of Latest Developments and Improvements in Manufacturers' Products Used in the Electrical Field

Fluid Meters

Various types of fluid meters have been developed by the Bailey Meter Company, 141 Milk Street, Boston, Mass., for measuring steam, water, air,

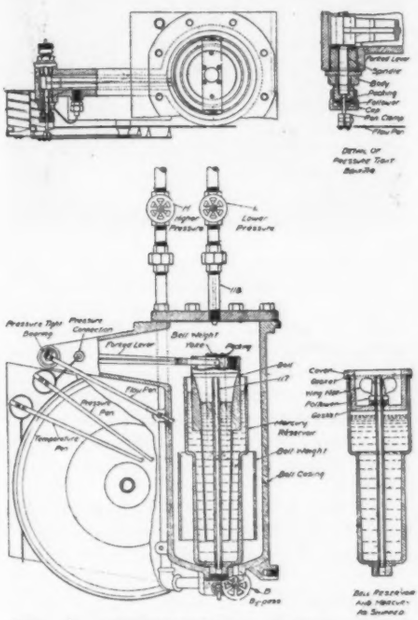


FIG. 1—CONSTRUCTION DETAILS, SHOWING MAIN OPERATING PARTS OF METER

gas or other fluid flowing through pipes at any pressure from a vacuum up to 300 lb. per square inch. They are suitable for use with superheated, saturated or exhaust steam in connection with turbines, heating systems, dye houses, cookers and evaporators, with feed water, hot-well discharge water, circulating water and general-supply water lines, with air from compressors and to distribution lines, and with natural gas, oil, etc.

In Fig. 2 is shown a Type C2 meter, as it is called, which is designed to measure the pressure difference across an orifice placed between a pair of flanges in a pipe line. The recorder can be used with Pitot and Venturi tubes. It is provided with an integrator which gives totals directly in pounds of steam, cubic feet of air or gas, etc. The over-all dimensions of the meter are 24 in. by 16.5 in. by 7.5 in. The orifice plate used is made of 1/32 in. Monel metal and forms its own gasket without any other packing. The size of the orifice is proportioned to the size of the pipe, the quantity and density of steam or other fluid flowing through it, so that about ½-lb. pressure drop is secured at average rates of flow. With this small pressure drop no cutting action occurs, it is said, and the orifice plate is entirely free from corrosion. A small drain hole is located in the orifice plate at the lower side of a horizontal steam pipe to prevent accumulation of water. There are but two moving parts to this meter, and they are not subjected to the direct action of the steam, hot gases or other fluid being metered. The pressure difference is applied to opposite sides of a special shaped bell sealed in mercury, and this acts like a frictionless piston, using the buoyant action of the mercury on the walls of the bell to balance the force due to the pressure difference. The bell has a variable cross-sectional area so that the recorder gives a reading which varies in direct proportion to the rate of flow. Charts with uniform graduations are used and the records can be easily read and totaled.

In Fig. 3 is illustrated a Type C1 meter which has been designed primarily for measuring and recording the rate of steam generation from boilers to show firemen how much steam

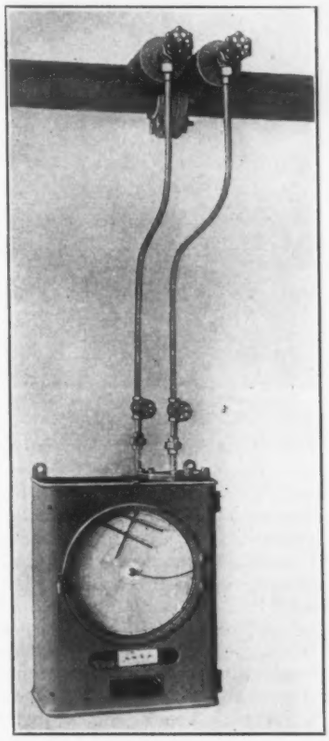


FIG. 2—METER THAT MEASURES PRESSURE DIFFERENCE ACROSS AN ORIFICE IN PIPE LINE

each boiler is making. It is also well adapted, it is asserted, for measuring flow of water, air, gases and other fluids. Records of the pressure and temperature of steam or other fluid may be made on the same chart with the rate of flow, thus giving the complete story of how much and under what conditions steam and other fluids are being used, as well as showing at just what time of day or night any

FIG. 3—METER FOR MEASURING AND RECORDING RATE OF STEAM FLOW

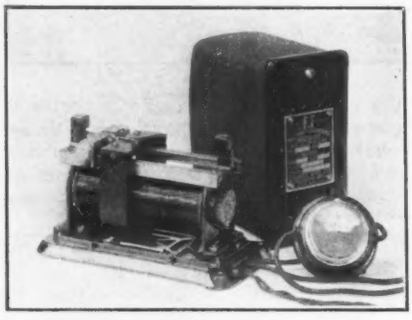
change occurred. The meter is 24 in. by 16.5 in. by 7.5 in.

Other meters of the Type C class are the Type C portable meter (Fig. 1), which weighs 70 lb. and can be divided for carrying, the interior working parts being identical with those of the other instruments described. A Type C4 meter is designed for measuring water and other liquids and is similar in design to the Type C2 device.

Magnetic Rectifier

To meet the demand for a battery-charging device which does not need fixed conditions of installation and constant attention or expert knowledge for operating it, the France Manufacturing Company, 1434 West Seventy-fifth Street, Cleveland, Ohio, has developed the magnetic rectifier shown herewith, which is designed to charge batteries rated at 8 volts or less from any 100-volt to 125-volt, sixty-cycle alternating-current lighting circuit at an average current rate of from 6 amp. to 8 amp. The rectifier is portable, measures 5 in. by 7 in. by 9 in. and weighs 12 lb. Use is made of an open-end step-down transformer which brings the line voltage down to the proper charging voltage. The transformer core is made up of soft-iron wires over which are wound the enameled copper wire

primary and secondary windings. The low-voltage charging current is passed through the rectifying element consisting of a master-spring armature, one end being rigidly attached to and in magnetic relation with the metallic end



MAGNETIC RECTIFIER FOR CHARGING BATTERIES WORKING AT 8 VOLTS OR LESS

piece of the transformer core, while the other end of the armature is free to vibrate between the fixed poles of a powerful permanent magnet. To the master spring are attached two opposite sub-springs, each of which carries a copper electrode which makes and breaks circuits alternately with a carbon electrode. The light-weight construction of the armature makes its action very positive, it is claimed, and allows it to come up to synchronism almost instantly. Compensation for wear on the carbon electrodes can be provided for by turning a thumb screw. The permanent magnet not only controls the vibration of the armature, it is pointed out, but acts as a magnetic circuit breaker opening the charging circuit when the alternating-current is turned off and thereby preventing the battery from discharging through the rectifier. Since the rectifier is self-starting, it will continue the charging upon resumption of the line current, making it entirely safe to leave a battery on charge during the night. It is also pointed out that the rectifier utilizes the negative as well as the positive alternations of current, producing a steady unidirectional flow for charging all types of storage batteries.

Electric Soldering Iron

A new device which has just been added to the Dover Manufacturing Company's (Canal Dover, Ohio) electrically-heated appliances is the soldering iron shown herewith. It is equipped with a flanged copper core which runs through

ELECTRICALLY HEATED SOLDERING IRON

the full length of the heating element. This core is drilled and tapped to take the copper tip. The heating element consists of two coils wound on a clay tubing insulated by refractory cement. The heating element is incased in a seamless steel tubing, and is permanently fastened to the grooved flange supporting the handle, and to the flange of the copper core. The terminal block is inside the handle, which is of seasoned wood and is hollow so that the cord can be led through it. The body of the iron and tubing supporting the handle is provided with a gun-barrel finish. The barrel is heavily enameled. The iron is being made in three sizes, taking 400 watts, 275 watts and 225 watts respectively at 110 volts. These irons are, respectively, 16.25 in., 15.5 in. and 14.5 in. long. The respective diameters of the tips are 1 7/16 in., 1.25 in. and 0.75 in. The respective weights of the devices are 54 oz., 39 oz. and 22 oz. The irons are being made for operation on pressures varying from 50 volts to 250 volts.

Electric Polishing Lathe

An electrically operated polishing lathe, with provision for salvaging the dust when working with valuable materials such as gold, platinum, etc., is shown in the accompanying illustration.

ELECTRIC POLISHING OUTFIT WITH ATTACHMENT FOR SAVING VALUABLE DUST

The complete outfit consists of a Westinghouse motor mounted on a pedestal equipped with fan, dust traps and universal hoods. The motor is being manufactured especially for J. C. Luden of Reading, Pa., who mounts it on the pedestal and markets the complete outfit. When polishing and grinding is being done the particles of dust flying from the wheels are thrown against the "universal" hoods and adjustable shields, and drawn down the vertical suction pipes. This dust is then separated from the air during the passage of the air through four traps which dispose of it without clogging the apparatus. In case only the polishing lathe is desired an outfit consisting of the motor mounted on a low base and equipped with various attachments for buffing, grinding, drilling, etc., may be provided.

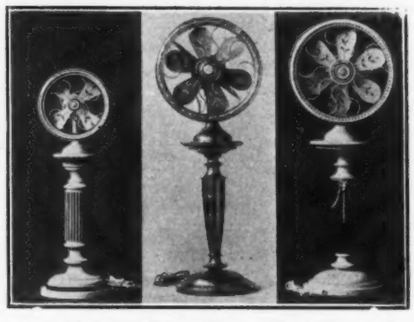
Decorative Fans

An interesting adaptation of a Western Electric 6-in. fan to decorative purposes is shown in Fig. 1. It is finished in Louis XVI design, and is equipped

FIG. 1—SIX-INCH ORNAMENTAL FAN MOUNTED ON WOODEN BASE

with a wood rim around the guard and a wooden base as shown. The finish is old ivory, and the blades are hand-painted. A white silk cord with Benjamin attachment plug is fastened to the fan. This fan is especially well adapted, it is pointed out, for use in the boudoir.

In Figs. 2, 3 and 4 are shown other types of artistically decorated fans mounted on stands of various period designs. The fan illustrated in Fig. 2 is finished in old ivory enamel with dark-brown striping and hand-painted blades. The fan is of Diehl make and of the 8-in. oscillating type. In Fig. 4 is shown a fan and fan stand of Adam design finished in old ivory enamel, the body of the fan stand being blue. The fan is a 12-in. Western Electric oscillating machine. The fan stand shown in Fig. 3 is 32 in. high and is finished in a dull gloss Chinese black lacquer. The



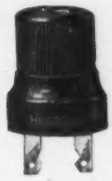
FIGS. 2, 3 AND 4—DECORATIVE FANS MOUNTED ON ORNAMENTAL PEDESTALS

fan is of the six-blade Western Electric oscillating type.

The ornamental fans described above are being placed on the market by the Crucet Manufacturing Company, 256 West Twenty-eighth Street, New York, and lend themselves particularly well to interior decorative schemes.

Composition Cap

A recently developed cap which can be interchanged with various types of Hubbell wall and flush receptacles is shown herewith. The device is of dur-

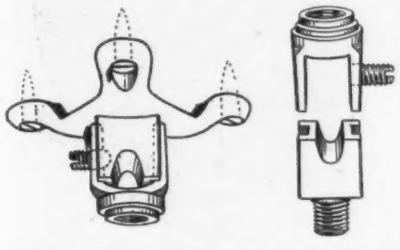


CAP WITH KNURLED NECK

able heat-proof composition material and provided with an elongated knurled neck which serves as a convenient grip. The neck is designed for use in withdrawing the cap from the receptacle and to take the place of cord sometimes used for the purpose. Harvey Hubbell, Inc., Bridgeport, Conn., is placing the device on the market.

Interchangeable Crowfeet and Hickey

Several types of interchangeable crowfeet, hickeys and fixture studs have been developed by the Jorsch Electric Manufacturing Company, Janesville, Wis., and are designed to serve as labor-savers in hanging straight electric fixtures and brackets. In Fig. 1 is shown the No. 102 separable hickey, as it is called. The male or stud end of the hickey is inserted in the fixture end of a combination insulating joint, thus making of it an electrolier or blind joint, and also providing the support for the fixture. The two pieces are then screwed in place and the whole fixture slipped together and held firmly by a set screw, making it unnecessary, it is pointed out, to hold up the whole fixture while catching the thread. With the hickey and crowfoot shown in the illustration the manufacturer claims there is no twisting of wires, no slots to weaken the hickeys, or chance to cross threads, no fishing of fixture wires or trying to catch the thread of the fixture to the stud in the outlet box from the top of a stepladder; instead the fixture is assembled in the shop, the only op-



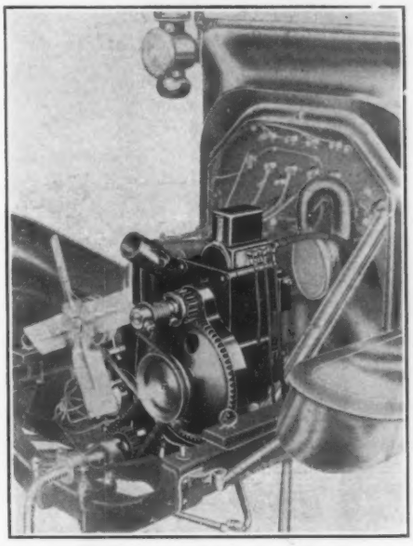
FIGS. 1 AND 2—CROWFOOT 1 IN. HIGH AND SEPARABLE HICKEY 13/16 IN. HIGH

eration necessary being to slip the hickey together and set up the set screw.

Attention is also directed to the fact that it is not necessary to carry the electrolier or blind joint in stock. The hickey also gives the man who hangs the fixture a reducing coupling any way he needs it.

Electric System for Ford Cars

A two-unit system for starting and lighting Ford cars has been brought out by the John O. Heinze Company, Springfield, Ohio, and is shown herewith as it is mounted on the car. The outfit consists of two independent machines, one being the starting motor and the other the lighting generator. The starting motor is series wound and is of the four-pole type. It operates at a high cranking speed and, according to the manufacturer, assures positive starting. By pressing the starting button on the dash the starting circuit

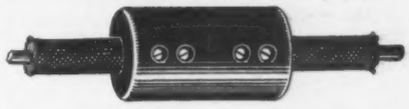


METHOD OF MOUNTING TWO-UNIT STARTING AND LIGHTING SYSTEMS ON FORD CARS

is closed, causing the automatic Bendix drive to mesh with the intermediate gear mounted on the generator shaft. A short, silent chain completes the drive to the crankshaft. The generator is also driven by a silent chain; is shunt wound, of the four-pole type; and is designed to operate at 6 volts. It begins to charge the battery at very low speeds, and when the car is operating at 10 m.p.h., the maximum charging rate is attained. This charging rate is then maintained constant at all higher speeds. The battery is placed in an enameled steel battery box, which is fastened to the running board. The dash switch controls the starting, lighting and ignition of the car by a single lever. When the switch is in the "off" position or in the position of "lights dimmed, ignition off" it may be securely locked to prevent tampering with the car when left at the curb or in the garage. The voltage and current-regulating device is mounted on top of the starting motor, as shown in the illustration. In installing the system, the manufacturer points out that it is not necessary to drill any additional holes or to use a file in any way.

Straight-on Insulated Connector

The Electrical Engineering & Equipment Company, 522 Wells Building, Milwaukee, Wis., is now marketing a "straight-on" insulated connector of the Roberson type. The device consists of a copper sleeve inside a cylinder

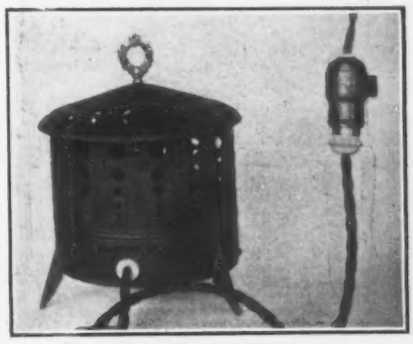


INSULATED CONNECTING DEVICE

of molded insulation. In making a splice the ends of the wires to be joined are inserted into the ends of the copper sleeve without removing the insulation from the wires. The four sharply pointed screws shown in the illustration pass through threads in the copper sleeve. When they are tightened they pierce the conductor insulation and make electrical contact. The path of the screws is not directly toward the center of the copper wire, but is slightly off center, so that a wedging as well as a piercing action takes place. The heads of the set screws are countersunk in the connector to insure safety against contact with any surrounding material. The manufacturer claims that these connectors when used in joining the leads to motors, controllers, testing equipment and other electrical apparatus, save time and material which with ordinary methods is lost in skinning wires, twisting ends together, soldering and taping. The connectors are made to fit all sizes of insulated wire from No. 16 to 1,500,000 circ. mil.

Electric Air Heater

In the accompanying illustration is shown an electric heater which takes 6 amp. at 110 volts and, according to the manufacturer, the C. H. Sharp Manufacturing Company, 1312 East Twelfth Street, Los Angeles, Cal., has been brought out to meet the require-



SIX-AMP. AIR HEATER

ments, both as to first cost and energy consumption of the man who can afford only modest expenditures. This No. 1 heater, as it is called, is built of No. 27-gage blue iron, and is without fancy trimming or finishes. It is so designed

that there is a constant circulation of air when in operation, the air leaving the top of the heater at a temperature of 275 deg. Fahr. The heater can warm from 2000 cu. ft. to 2500 cu. ft. of air per hour and will raise the temperature of a small room, such as a bath room, it is claimed, from 60 deg. Fahr. to 72 deg. Fahr. in approximately twenty minutes. The heating unit is suspended in the center of the device somewhat in the same manner as the filament of a tungsten lamp is suspended.

Ranges with Sheathed-Wire Heating Units

Rathbone, Sard & Company, of Albany, who have been making stoves under the trade name of "Acorn" for more than fifty years, have recently taken up the manufacture of electric ranges. These ranges are being made in three types, and several modifications of these types, making seven models altogether. The E-5 range is compact and takes up little floor space, the E-20 range is a cabinet-type range, and the E-30 range is of the "Baby Grand" type. They are fitted throughout with General Electric sheathed-wire heating units. All the ovens are equipped with two heating units, one being in the top for broiling and the other in the bottom for roasting. The oven units are controlled by selective switches and therefore the two units of an oven cannot be in circuit at the same time. The top unit is rated at 1500 watts and the lower at 100 watts on low heat and 500 watts on high heat. A fireless cooker compartment can be provided if desired. All the hot plates operate on three heats, taking 100 watts, 250 watts and 500 watts respectively.

In designing the electric ranges the manufacturers have followed closely

FIG. 1—RANGE WITH WARMING CLOSET AND SEPARATE BROILING COMPARTMENT

the design of gas ranges. They have been developed to meet the requirements of the average kitchen for the average family and have been made as simple in operation as possible. The sheathed-wire heating unit permits repeated cleansing of the various parts of the ranges, it is declared, without danger of shock or short-circuiting, and the hot plates are said to be almost as durable as pig iron.

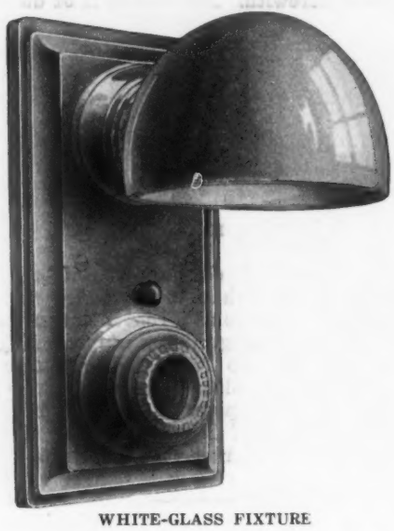
The type E-5 range is shown in Fig. 2, and is provided with a cooking top which is quite high, being especially convenient for people who are over 5 ft. 3 in. in height. The cooking top can be reached from three sides. All the switches are in the front where they can be readily reached. The range is equipped with four hot plates, one broiler unit and one roasting unit, and has a total rating of 5500 watts. The Type E-20 cabinet range is equipped with a high roasting oven, high shelf, white-enamel splashers and separate broiler compartment under oven with independent switch which is in addition

FIG. 2—COMPACT RANGE RATED AT 5,500 WATTS

to the broiling unit in the oven. It has a strong foundation frame with legs joined to the base by a dovetail joint so that it will not wabble. The range is equipped with four hot plates and has a total rating of 7000 watts. The type E-30 range, shown in Fig. 1, is provided with a high roasting oven with shelf, upper warming closet with canopy over the cooking top heated from roasting oven, white-enamel splashers, separate broiler compartment under roasting oven and four hot plates. It has a total rating of 7000 watts.

White-Glass Lighting Fixture

Among recent developments in lighting fixtures is a line of "Aglite" white-glass units, as they are called, which have been placed on the market by the Luminous Unit Company, St. Louis, Mo. The fixtures are being made in a variety of styles, including ceiling types with either one or two lamps and wall brackets which, in addition to the lamp socket are equipped with a receptacle in which an attachment plug may be inserted. Each type is provided with or without shades or reflectors as desired. The usual wall switch may be

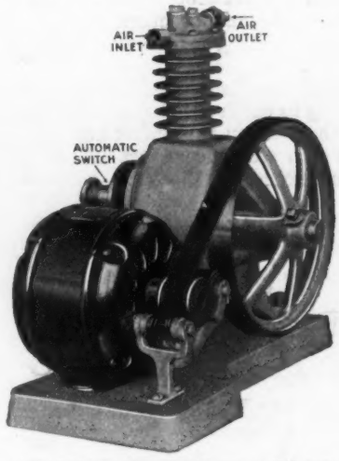


WHITE-GLASS FIXTURE

eliminated, since each fixture may be equipped with a self-contained turn or pull switch if desired. The fixtures are especially well adapted for use in interiors such as bathrooms, bedrooms, hospital, etc., where the white glass harmonizes with its surroundings.

Electric Air Pump

In the accompanying illustration is shown a small type No. 199 "Eureka" motor-driven air pump, as it is called, which is adaptable for use as a beer pump and for supplying air for physicians and artists. The complete outfit is 14 in. high, 15 in. wide and 11 in. deep and is designed to supply air at pressures up to 35 lbs. per square inch. The single cylinder is 1⅜ in. by 2⅜ in.



AIR PUMP OPERATED BY 1/15-HP. MOTOR

in size. The air compressor is operated by 1/15-hp. motor. When the maximum pressure is attained the motor is automatically stopped. The outfit is being placed on the market by the Bishop-Babcock-Becker Company, Cleveland, Ohio.

NEWS OF THE INDUSTRY

A Review of Activities in the Electrical Manufacturing, Selling and Central-Station Fields

"Spring Opening" Doubles Electric Shop Business at Chicago

Following the practice long established in department stores and other large mercantile institutions the electric shops of the Commonwealth Edison Company, Chicago, set apart the week of April 10 to 17 for a spring opening. For that week the company's advertising in all the English newspapers of the city carried artistic designs symbolic of spring. The text told the story of no one product in particular but pointed out that "The graceful artistry and pleasing pattern of the new styles electrical follow closely the prevailing vogue in furniture fabrics, decorations and colors," and mentioned the "special price inducements offered in various lines."

Spring Display
1916
April 10 — April 15
The graceful artistry and pleasing pattern of the new Styles Electrical follow closely the prevailing vogue in furniture, fabrics, decorations and colors.
To the attractiveness of the complete display of the new Things Electrical now being exhibited, we have added special price inducements in various lines.
Electric Shop
72 WEST ADAMS STREET
CORNER CLARK STREET
COMM JACKSON
AND MICHIGAN
BOULEVARDS

NEWSPAPER ADVERTISEMENT OF COMMONWEALTH EDISON COMPANY, CHICAGO

To a selected list of 60,000 residential customers was sent an attractive announcement booklet done in apple green, delicate pink, brown-green and gold. Both the art work and the copy in the booklet were designed to link electrical devices with summer comforts in the minds of the readers. The booklet was also designed to instill a desire to visit the electric shops.

On Monday, April 10, the first day of the opening this new electric shop at Clark and Adams Streets did about twice the volume of business it usually handles on Mondays. This increase was attributed by E. A. Edkins, manager of the store, directly to the advertising.

Casualties Show Need of Safety Measures

The American Museum of Safety has compiled statistics showing the number of workmen killed and injured annually in American industries. "The United States," says Arthur Williams, its president, "is continually waging a bloody war within its own borders—a war in which the casualties amount to 35,000 lives each year and in which the total number of wounded annually is 1,590,900.

"Although The American Museum of Safety is an institution of peace we believe that through making industry safer and conserving our resources in men we are achieving a great deal toward preparedness. The museum is bending all of its energies to saving at least a large percentage of the 35,000 killed and the 1,500,000 injured annually. I believe that more than 50 per cent of both can be prevented. We have actual proof at the museum of where accidents and fatalities have been reduced 50 per cent and in many instances much more than 50 per cent in a single year in the most hazardous industries. The museum is now planning the Third National Safety Exposition which will take place in New York, May 22-27. One of the lessons which we hope to teach at the exposition this year is that the way of preparedness lies through safety for the lives and limbs of our workers."

Public Service Commission News

New Jersey Commission

The New Jersey Court of Errors and Appeals recently handed down a decision holding that the agreement made by the city of Plainfield with the Public Service Electric Company for free lighting in 1898 was a legal contract and should be fulfilled by the company. This ruling sustains the Board of Public Utility Commissioners which ordered the company to carry out its agreement, and reverses the decision of the Supreme Court. The case has been contested since February, 1914, when the company advised the Plainfield authorities that it would discontinue the lighting service existent since the granting of a franchise, as same was a discrimination and not allowable according to the public utility act of 1911. Closely following, in April, 1914, the utility commissioners upheld the city's contention that the free lighting provision was not a discrimination and ordered the company to maintain such service. In March, 1915, the Supreme Court, to which the case was appealed, reversed the findings of the Board of Public Utility Commissioners on the ground that the spirit of the utility act was violated by the free service. The Court of Errors and Appeals in its decision points out that the utilities act is prospective and not retroactive, and accordingly could not be applied to the Plainfield contract made in 1898 and lawful when made.

California Commission

The Railroad Commission has issued orders establishing new rates and rules for the service of electricity by the San Joaquin Light & Power Corporation and the Mount Whitney Power & Electric Company. The flat rate for twelve months' agricultural power service is cut from $50 to $42.30 a horsepower, and an equitable scale made for all uses of electricity. Transformers and reasonable extensions are to be furnished free to the consumers and the contract term for agricultural power is reduced from five to three years.

The value of the property of the San Joaquin corporation in its electric business is set at $10,054,540, and that of the Mount Whitney company at $4,841,197. The rates now fixed by the commission will return these corporations 8 per cent, and are more an adjustment and an equalization of charges than a lessening of the incomes of the companies, permitting them to expand

with the needs of the communities they serve. A reciprocal contract between the companies for the sale to each other of electric energy is provided in lieu of the present contracts. The commission commends the Mount Whitney service as excellent and its policy with reference to extensions as fair, and says that the San Joaquin corporation service has improved greatly during the last year.

In its decision the commission draws particular attention to the fact that most farmers need electric energy for pumping only seven to nine months a year. It therefore establishes seasonal monthly rates to give farmers electric energy as needed, and makes flexible seasonal agricultural pumping rates to meet their requirements. Transformers costing $65 each on an average are henceforth to be supplied by the utility companies, and allowances are made to permit those corporations to purchase at reasonable prices all transformers owned by consumers. Agricultural power contracts, limiting use of electric energy to pumping irrigation water, are changed by the commission to permit farmers to use this power for any purpose.

The companies are directed to omit from contracts provisions giving the corporations a lien on the consumer's land for unpaid bills, the right to build the companies' lines without compensation over the farmer's land beyond his installation, and the waiving possible damages on the farmer's part. These clauses are stricken from the contracts. The minimum monthly charge for residence lighting is reduced from $1 to 75 cents, and the residence lighting from 10 cents per kilowatt-hour to a block system starting with 8 cents.

Maine Commission

A precedent was set by the Maine Public Utilities Commission on April 1 in its order authorizing the Mars Hill & Blaine Electric Light & Water Company to issue a stock dividend as a division of surplus. The decision of the commission is in part as follows:

"The rates have at all times been reasonable compared with those charged by such utilities in other communities, and no complaints have reached the commission, none exist so far as the commission has learned. The success of the company in building up a surplus of such comparative proportions appears to be explained by the fact that it did a profitable business from the start and has never paid any dividends to stockholders or salaries to officers.

"It now wishes to divide these earnings in the form of a stock dividend to the face value of its original authorized capitalization. We can see no objection to this so far as the public is concerned. It will not mean the withdrawal of any assets from the corporation, and the stock will still represent in money actually in the plant more than its par value. It will not be 'watered stock.'

"If neither the public nor the security holders will suffer in any way from the contemplated action, whether it will be of any real benefit to the stockholders is a question with which they alone are concerned. It is, however, probable that there will be some substantial advantage in case of future extensions requiring additional capital, because new stock can be sold at nearer par without injustice to present stockholders, and would thus be more attractive to the less experienced investor. That such a contingency is not unlikely is shown by recent action of the stockholders in voting to increase the authorized capital to $20,000, 'to be sold as funds may be required for the extension and improvement of its lines.'

"There appears then to be no reason why the prayer of the petitioner should not be granted if there is legal authority for it. This question is here presented for the first time, and has received careful consideration.

"The public utilities act provides for the issue of 'stocks, bonds, which may be secured by mortgages of its property, franchises or otherwise, notes or other evidences of indebtedness payable at periods of more than twelve months after the date thereof, when necessary for the acquisition of property to be used for the purpose of carrying out its corporate powers, the construction, completion, extension or improvement of its facilities, or for the improvement or maintenance of its service, or for the discharge or lawful refunding of its obligations, or for such other purpose as may be authorized by law.'

"The act proceeds to prescribe that no such securities shall be issued until this commission has certified that it is required for one of these purposes. Clearly this is not the case. But as the law relating to public utilities now stands, this is the only affirmative provision for the issue of stocks. If power to declare a stock dividend exists, it would seem that it must be read into the act.

"No public utility shall decrease its capital stock or declare any stock, bond or scrip dividend or divide the proceeds of the sale of its own or any stock, bond or scrip among stockholders without the consent of the commission.

"If it were not intended that such corporations should retain the privileges they had previously enjoyed in this respect, it would have been useless to write this negative provision into the law. We must, and do, conclude that this section of the act was intended only to apply to the issue of stock in the usual manner for the purpose of securing new capital, and that it puts no restriction on the division of accumulated earnings by the issue of certificates of ownership therein instead of paying out the money in the form of cash dividends."

Idaho Commission

The Public Utilities Commission has rendered a decision in the complicated case of the village of Roberts versus the Ashton & St. Anthony Power Company, Ltd., vacating the certificate of convenience and necessity granted the company. The evidence showed that there was absolute necessity and immediate demand for electrical energy in the village of Roberts, and the Ashton & St. Anthony company voluntarily offered to relinquish its rights to supply the village provided its rights in other territories covered by its certificate were not affected. Therefore, the Ashton & St. Anthony company's certificate still holds good in the territory in the vicinity of Mud Lake, the area of which is about 80,000 acres, which will be irrigated by the Owsley Carey Land & Irrigation Company, Mud Lake Canal Company, North Lake Canal Company and Crystal Lakes Irrigated Lands Company, which companies were intervenors in the case, together with various farmers under the Butte & Market Lake Canal. The Ashton & St. Anthony company has already begun the construction of its dam and power house about 2 miles west of Ashton, which when completed will give the system a capacity of 5000 hp. at an estimated cost of about $325,000, one-third of which has already been expended. The Utah Power & Light Company, it was represented, is prepared to serve the village of Roberts and vicinity within sixty days after the commission grants it the right. The decision states that while the evidence shows that there is some demand for power to operate pumping plants for irrigating lands in the vicinity of Mud Lake during the irrigation season of 1916, it is not clear that the demand is sufficient to justify either the Ashton & St. Anthony or the Utah Power & Light companies to serve this territory before the opening of the 1917 irrigation field. A further hearing in the case has been set for Aug. 1, 1916, in Boise.

Boston Edison Company Largest Taxpayer in Boston.—The Edison Electric Illuminating Company of Boston, Mass., is the city's largest taxpayer, paying $457,340.40 in taxes this year on a valuation of $7,157,800 of real estate and $18,250,000 of personal estate.

Municipal Plant Forced to Raise Rates.—Inability to pay expenses at the old rates has resulted in the City Council of Ellensburg, Wash., taking action to raise lighting and power rates of the municipal plant an average of 10 per cent. The great number of lighting warrants outstanding is given as the reason for the action being taken.

Power Customers Plan Protective Association.—The power customers of Tulare County, Cal., are planning an organization of a county power customers' association for mutual protection and benefit. It has been suggested that the organization might secure power at wholesale rates for clubs that would take 300 hp. to 500 hp. to be used to best advantage of their members.

Hand-Holes Essential in Gas-Engine-Station Piping.—In an old gas-engine-driven electric-light plant which the Hoopeston (Ill.) Gas & Electric Company recently dismantled the pipes leading from the gas producers to the engines were found partially filled with dust, pitch and dirt. When the station was built several years ago elbows and other bends of common variety were placed in the piping. These fittings, according to H. D. Hayden, manager of the property, should all have been provided with hand-holes, which would have made it possible to keep the lines clean without tearing up the entire line.

New Electric Signal Lamp.—It was announced that E. G. Fischer, chief of the instrument section of the Coast and Geodetic Survey, Department of Commerce, has just completed the design and construction of an electric signal lamp, which will be used during the coming summer in the mountainous regions of Idaho and Oregon on primary triangulation, where the distance between stations is frequently as much as 100 miles. The lamp has a specially-designed filament, and will receive its energy from an ordinary dry cell. It has been tested by the Bureau of Standards and is declared to be more than 150 times as powerful as the acetylene signal lamps which have been used for a number of years by the Survey.

German Province Takes Over Power Plant.—In a wireless dispatch from Berlin it is announced that the Province of Brandenburg, in order to systematize the distribution of electric light and power in the province, has taken over the Brandenburg Electric Company which controls the Berlin Suburban Electric Company. The provincial government, it is stated, will make a contract to supply power to Berlin railways and to the whole province. An agreement has been made with a general electric company to finance the acquisition of control in the Brandenburg Electric Company. The scheme follows the principle adopted by the government of joining with private enterprises in corporation management.

Current News and Notes

Timely items on electrical happenings throughout the world, together with brief notes of general interest.

War Heightens French Hydroelectric Development.—In contrast to the steam plants which have suffered from the enhanced price of coal the hydroelectric plants of France, according to the *Revue Electrique*, are in a very prosperous condition. The available power in the existing developments has been rapidly utilized to capacity, and several falls, the development of which were contemplated before the war, are now being harnessed to supply the energy.

Legal Technicality Prevents Memphis from Acquiring Local Power Plant.—The plans of the City Commission of Memphis, Tenn., to take over the plant of the Merchants' Power Company which was halted by a suit questioning the authority of the city to buy, rather than to build a plant, under the legislative enactment, have received a further setback. The circuit court sustained the city in this phase of the case, but entered an injunction against the issuance of the $1,500,000 of bonds, holding the bonds to be invalid, because the election was not advertised as the law requires.

New Bill on Pole Location Before Massachusetts Legislature.—The committee on mercantile affairs of the Massachusetts Legislature has voted to report a bill relating to the granting by cities and towns of locations for poles and wires for the transmission of electrical energy. The bill repeals the requirements that the clerk of a city or town shall keep in books, kept exclusively for the purpose, the records of the locations of poles and wires, and provides that the Mayor and Board of Aldermen of a city or the Selectmen of a town may, upon written petition, grant permission for joint or identical locations to another company without notice or hearing.

Transmission Company Gives Small Towns Twenty-four-Hour Service.—Twenty-four-hour electric service for the village of Morristown, and possibly other near-by places in St. Lawrence County, was assured on April 3, when the Public Service Commission, Second District, New York, approved the franchises of the Gregory Electric Company for the construction of a transmission line for Heulveton through the towns of Oswegatchie and Morristown to the village of Morristown. The Gregory company, operating in Morristown, has been getting all of its current from the W. H. Comstock Company, Ltd., and giving service from sunset to midnight and from 5 a. m. to sunrise. The company has now made a contract with the St. Lawrence Transmission Company for twenty-four-hour supply of current.

A City's Interest in Foreign Trade.—In a speech before the Board of Trade of Schenectady, N. Y., at its luncheon in the Edison Hotel on April 6, M. A. Oudin, manager of the foreign department of the General Electric Company, dwelt on the importance of foreign markets to Schenectady as a community. Mr. Oudin pointed out the national questions involved and voiced the necessity of the country's taking steps to meet competition which is expected to increase immediately after the present war is over.

Bill Submitted Reducing Massachusetts Commission Membership.—The special committee on Massachusetts commissions has submitted a bill to the Legislature reducing the membership of the Public Service Commission from five to three and establishing salaries of $7,500 for the chairman and $7,000 each for the other two members. The present board has four members receiving $8,000 each, with a chairman who receives $8,500, all holding office for five years. Under the new bill the members would be appointed by the Governor with the consent of the executive council as at present, the term, however, being reduced to three years. By the new bill the salaries of the commissioners are to be paid by the State, the other expenses of the board being met by the public utilities under its jurisdiction. The new board is to exercise all powers and duties of the existing commission, and the attempt to transfer the regulation of telephone and telegraph companies to the Gas & Electric Light Commission has fallen through.

Photometry of the Gas-Filled Lamp.—The new high-efficiency gas-filled lamp introduces variables not hitherto encountered in the photometry of incandescent electric lamps, according to the Bureau of Standards, which has been making a study of this matter, results of which are now published in Scientific Paper No. 264. It was found that at constant voltage both the energy consumed and the candlepower are different when the lamp is rotating than when it is stationary, the energy changing in one direction and the candlepower always in the opposite direction—that is, there is a change in the operating efficiency of the lamp. This change in efficiency was found to be about twice as great when the lamp is rotating tip up as when it is tip down. As to the cause of the variations observed in candlepower and efficiency when the lamp is rotated, it was calculated from the results of a number of special tests that the whole effect is produced by a change in the convection currents of the gas, a consequent variation in the temperature distribution in the bulb, resulting in a change in the resistance, and therefore a variation in the current and candlepower of the lamp. A further peculiarity of the gas-filled lamp is that while it burns the blackening occurs, not all over the bulb in approximate proportion to the light distribution as in the vacuum lamp, but principally at the top of the bulb because the volatilized material is carried upward by the gas.

The Electrical League of Cleveland.—E. S. Wertz, United States District Attorney, addressed the league on April 13 on the subject: "The U. S. District Attorney and the Public."

Chicago Electric Club-Jovian League.—On April 6 Walter H. Bennett, State fire marshal of Illinois, spoke before the Electric Club-Jovian League, Chicago, on "The Shame of the State."

Los Angeles Jovian League.—At a meeting of the Jovian Electric League of Los Angeles on April 5, I. B. Potter, attorney for the Southern Sierras Power Company, spoke on "Co-operation."

New York Jovian League.—Maj.-Gen. Leonard Wood was the guest of honor at the regular Wednesday luncheon of the Jovian League of New York City on April 12. He spoke on the subject of "Preparedness."

National Fire Protection Association.—The twentieth annual meeting of the National Fire Protection Association will be held in the auditorium of the Insurance Exchange Building, Chicago, Ill., on May 9, 10 and 11.

New England Section, I. E. S.—Dr. Charles P. Steinmetz, president of the Illuminating Engineering Society, spoke on April 13 before the New England Section of the society on "Illumination of the Present and Developments to Be Expected in the Near Future."

Vancouver (B. C.) Electrical Contractors & Dealers.—The British Columbia Association of Electrical Contractors & Dealers has just been organized with C. H. E. Williams as president and E. Brettell of the Electric Supply Company, Ltd., of Vancouver, as secretary-treasurer.

Lynn Section A. I. E. E.—The closing lecture in the winter course of the Lynn section of the American Institute of Electrical Engineers was delivered on April 5 by L. E. Underwood, engineer of the motor department of the Lynn works of the General Electric Company. The subject was "Progress in the Art of Motor Design and Manufacture."

Washington University Branch, A. I. E. E.—H. W. Eales, chief electrical engineer for the Union Electric Light & Power Company of St. Louis, addressed the members of the Washington University branch of the American Institute of Electrical Engineers on April 6 on the topic, "Some Experiences in the Operation of a Large Light and Power Company."

Institute of Radio Engineers.—A meeting of the Institute of Radio Engineers was held on April 5 at the Engineering Societies' Building, New York City. A paper by Dr. Louis W. Austin on "Experiments at the U. S. Naval Radio Station at Darien, Canal Zone," was read, giving data on the ultraudion in reception and the effects and reduction of strays.

New York Section, I. E. S.—The next meeting of the New York section of the Illuminating Engineering Society will be held on May 11. Steven De Kosenko and Douglas Nash will conduct a symposium on fixtures and lighting glassware. The June meeting will be held on June 8 as an outdoor meeting. W. T. Dempsey will present a paper on "Electric Street Lighting in New York."

Associations and Societies

A complete Directory of Electrica Associations is regularly printed in the first issue of each month on the next-to-last text page.

Minnesota Section, A. I. E. E.—An illustrated lecture on "Heavy Steam Railroad Electrification of the Chicago, Milwaukee & St. Paul and the Butte, Anaconda & Pacific Railway" was given by George H. Hill, assistant engineer of the railway and traffic engineering department of these roads, and A. L. Rohrer, electrical superintendent of the General Electric Company, before a joint meeting of the Minnesota Section of the American Institute of Electrical Engineers and the Minnesota Engineering Society on April 14 at the University of Minnesota, Minneapolis.

Puget Sound Branch, A. C. S.—The possibilities of developing in the State of Washington the manufacture of electro-chemical supplies was discussed in four papers read before the Manufacturers Association on March 25 by members of the Puget Sound branch of the American Chemical Society. The papers were: "Opportunities for Electro-Chemical Industries," by C. E. Bogardus; "Bleaching Powder Costs," by W. R. Hainsworth; "Artificial Abrasives," by Prof. Joseph Daniels, and "The Manufacture of Alkalis from Salt by Electro-Chemical Methods," by Prof. H. L. Trumbull.

Fourth Annual Meeting of Society for Electrical Development.—The fourth annual meeting of the Society for Electrical Development will be held in the Engineering Societies Building, New York City, on May 9. In addition to the regular routine matter of electing the board of directors, and receiving the annual report from the general manager of the society, J. M. Wakeman, the society will vote on two technical amendments to the by-laws. It is expected that the plan committee will make a comprehensive report on the extensive work scheduled to be carried on by the society for the next year.

New-Business Committee, Ohio Electric Light Association.—The tentative program for the May meeting of the new-business co-operations committee of the Ohio Electric Light Association to be held at Newark, Ohio, on May 12 is as follows: "Increasing the Sale of Ice Machinery Through Co-operation with the Central Station," by Charles Gilbert, manager of sales Huetteman-Kramer Company, Detroit, Mich.; "Electric Furnaces," by a representative of the Snyder Electric Furnace Company, Chicago, Ill.; "Talks or Demonstrations of Electrical Appliances, Together with New Ideas of Sales Promotion," by Dexter Rollins, Simplex Electric Heating Company; J. E. Swan, Hotpoint Electric Heating Company; I. B. Terry, General Electric Company; "Motor Drive as Against Gas Engine Drive for Power Purposes," by H. B. Craft, Columbus Railway, Power & Light Company.

Convention of Oklahoma Utilities.—The fifteenth annual convention of the Gas, Electric & Street Railway Association of Oklahoma will be held May 23 to 25 in Oklahoma City, the headquarters being at the Lee Huckins. Following is a list of the papers scheduled for presentation: "Safety First, Gas and Electric Street Railway," by J. J. Johnson, assistant general manager Oklahoma Railway Company, Oklahoma City; "Taxation of Public Service Corporations," by Prof. J. W. Scroggs, director of extension division University of Oklahoma; "Development of New Business," by R. K. Johnson, secretary-treasurer Washita Electric Power Company, Pauls Valley, Okla.; "Diesel Oil Engines," by Prof. L. W. W. Morrow of the University of Oklahoma; "Fuel Efficiency," by A. J. Neff of the American Public Service Corporation, Abilene, Tex.; "Report of the Rate Research Committee," by S. B. Ireland of the Bartlesville Interurban Railway Company; "Operation and Maintenance of Gas Distributing Systems," by J. F. Owens of H. M. Byllesby & Company; "Privately Owned Utilities and the Public," by W. R. Molinard, manager Oklahoma Gas & Electric Company. H. V. Bozell, of Norman, is the secretary-treasurer of the association.

Philadelphia Electric Company Section N. E. L. A.—The March activities of the Philadelphia Electric Company's section of the National Electric Light Association included an address by H. L. Doherty on the general subject of "Public Relations and Policy."

The meeting of the meter department branch was addressed by P. H. Bartlett, superintendent of the meter and installation departments of the company, who, in an informal talk, sketched the growth of these departments and indicated the possibilities for future expansion with resultant opportunities for individual advancement.

The meeting of the engineering department branch was addressed by E. A. Turner, who spoke on the work of the aerial line department.

Five ten-minute papers were presented at the meeting of the commercial branch and they covered the following subjects: "Contract Routine with Reference to Placing of Meter," by P. C. Glassey; 'Contract Routine with Reference to Installing Service," by B. A. Looby; "The Arguments Used in Explaining the Reason for a Minimum," by I. H. Mulford; "The Best Answer to the Question 'Why Should I Make a Deposit?'" by J. Mervish; "Methods of Handling Service Complaints from a Commercial Viewpoint," by F. P. Smith.

The April meeting of the section will be addressed by Edward F. Trefz, field secretary of the United States Chamber of Commerce, on "Judgment, Enthusiasm, Obedience and Loyalty."

FINANCE, COMMERCE AND INDUSTRY

News of the Trade for the Manufacturer, Wholesaler and Jobber of Electrical Equipment and Supplies—Notes on Industrial Activities and Business Methods

Manufacturing and Industrial

The Market for Pressed Steel Ornamental Lighting Standards

An article which was published in these columns on Feb. 26 discussed the general trade conditions in street lighting standards. It was based largely upon information which was obtained from manufacturers of cast-iron standards rather than upon information from the manufacturers of all types, including pressed-steel standards. With fuller information at hand than was obtained at that time, the ELECTRICAL WORLD is able now to correct some of the impressions that may have been left by that article and to supplement the data by a statement of the facts concerning the present market tendencies in ornamental lighting standards.

The demand for pressed-steel standards has been increasing steadily and the prospects for the current year are that previous records will be excelled. The pressed-steel standard is finding a sure market in all sections of the country where there is a special demand for ornamental lighting effects. The structural advantages of this type of standard are bringing it additional recognition for use in "White Way" lighting and in high-class residential districts. Its particular advantages for these purposes have caused it to be selected for a large number of recent extensive installations.

It is recognized that the manufacture of ornamental street lighting standards is comparatively a new industry, but it has developed so rapidly during the past ten years that already the manufacturer of pressed-steel standards has placed successful installations in more than 1000 cities and towns in all parts of the country. Two of the more recent applications of this type were in Cleveland and Youngstown for nitrogen-filled lamps. The adoption of these standards in those cities on so large a scale has given an added impetus to "White Way" work and has already resulted in several additional installations with this type of standard and lamp.

The competition between the different kinds of street lighting standards does not arise from price so much as from other considerations. As in all other transactions between buyer and seller, the purchaser is guided by self-interest in determining what particular product he will buy and what terms he can make as to price. It is the duty of a buyer to satisfy himself on the question of time of delivery. However, it is of interest to note that the prices of pressed-steel standards have not been advanced materially. Such standards have always been sold at prices practically the same as cast-iron poles of similar design and dimensions, and the increased production facilities of the manufacturer of pressed-steel standards insure more prompt deliveries now than at any previous time in the history of the industry.

Outside of the increasing popularity of pressed-steel standards, it is of importance from a trade standpoint to mention the influences which are promoting a higher class of ornamental lighting in growing communities. Foremost in importance is the development in lamps and the steady appreciation of the results obtainable from the gas-filled unit. Next is the keener feeling of civic pride, and, last, is the growing realization of merchants throughout all industries that better lighting is an indispensable requirement in progress. The number of cities that install modern, attractive systems on their "show" streets always grows larger, and upon this condition the manufacturers of lighting standards base their expectation of steady increase in output.

Different qualities and advantages of product are claimed by the manufacturers of lighting standards now on the market. Since the article published on Feb. 26 was based mainly upon information obtained from the manufacturers of cast iron standards, some attention will be given in the present issue to the attitude of the Union Metal Manufacturing Company, the manufacturers of pressed steel standards.

C. L. Eshleman, vice-president of the Union Metal Manufacturing Company, in speaking to a representative of the ELECTRICAL WORLD, expressed confidence in the market for the coming year. He believes that the great public interest which has been aroused by the many successful street lighting effects is a guaratnee of largely increased orders. In the last two years this company has furnished standards for a steadily growing list of cities. Among the more important of the installations in size are those in Mansfield, Akron and Sandusky, Ohio, besides the comprehensive systems mentioned for Cleveland and Youngstown. Cities in other parts of the country in which installations of good size have been placed are Buffalo, Syracuse and Watertown, N. Y.; Nashville, Tenn.; San Antonio and Fort Worth, Tex.; Cheyenne, Wyo.; Grand Rapids and Sault Ste. Marie, Mich.; Spokane, Wash.; Glendora, Covina, Hermosa, Pasadena, South Pasadena, San Francisco and Culver City, Cal., and Sheboygan, Wis. The company has also placed installations of noteworthy extent in Galt, Ont.; Winnipeg, Man., and Saltillo, Mexico.

An unusual feature of the arrangement which this company makes with its customers is a guarantee to replace at any time within twenty years from the date of erection any of its pressed-steel shafts that fail from any cause (except by willful, malicious damage) for the nominal sum of $3 each net, f.o.b. its factory in Canton, Ohio. It has been found that the pressed-steel shaft, coupled with internal steel-rod construction, in withstanding collisions from trucks or heavy vehicles, will bend instead of break. This is an additional element of safety for pedestrians.

In the item of cost, the manufacturer of pressed-steel standards secured protection by the purchase of material before the present era of general high prices developed. It is the opinion of Mr. Eshleman that current quotations for steel represent substantially the peak of the advance and that the next decided change will be a reaction.

The Delta Star Electric Company of Chicago has erected a new factory at 2433 Fulton Street, and has recently moved into its new quarters. H. W. Young is president of the company.

The Ward Leonard Electric Company, Bronxville, N. Y., has changed the address of its Pittsburgh office from Baum and Euclid Streets to 901 Park Building. This office is in charge of John B. Sebring.

The Philadelphia Electrical & Manufacturing Company, 1228 North Thirty-first Street, Philadelphia, Pa., has appointed J. M. Rickard, formerly with the Metropolitan Engineering Company of New York, a member of its sales force.

Lenz & Naumann, Inc., who are engaged in the sale of laboratory apparatus and supplies, have removed their offices, showrooms and warehouse to more convenient and commodious quarters at 9 East Sixteenth Street, New York.

The Kandem Electric Company, New York, has recently moved from 49 East Twenty-first Street to larger quarters at 29 East Twenty-first Street. This change has been necessitated on account of a considerable increase in business.

The Bartlett-Yates Insulation Company, 64 Murray Street. New York, has recently been formed and will deal in various kinds of electric insulating materials. H. M. Bartlett is president of the concern and John S. Yates, secretary. Both Mr. Bartlett and Mr. Yates were recently connected with the Mitchell-Rand Manufacturing Company.

Order for Generating Equipment.—The Mission Range Power Company of Holson, Mont., has contracted with the General Electric Company, Schenectady, N. Y., for the following hydroelectric equipment: Two 200-kva., 514-r.p.m., 2300-volt 60 cycle generators, two 14-kw. belted exciters, four three-phase 200-kva., 16,500-volt to 2300-volt transformers and switchboards.

Canadian Embargo on Asbestos.—According to a telegram sent out by the American Consul-General at Ottawa, the asbestos embargo order which was recently passed has not yet become effective. By this order, exportation will be limited to British countries, except under license. The Consul-General feels assured, however, that licenses will be granted for shipments to the United States.

Delco Agents Hold Meeting.—A gathering of more than 100 salesmen, sales agents and general agents of the Dayton Engineering Laboratories Company of Dayton on March 23 was featured by a dinner at which Vice-President Deeds, General Manager R. H. Grant and a number of others made addresses. The possibilities of the new power unit to be manufactured by the Domestic Engineer Company, an affiliated concern, were discussed.

Mr. Manuel Nacher, representing the firm of Valencia Steam Navigation Company of Valencia, Spain, has registered at the New York office of the Bureau of Foreign and Domestic Commerce and is anxious to get in touch with manufacturers of electric welding machinery and marine type Diesel motors. Catalogs and offers should be addressed to him care of the Commercial Agent in Charge, Bureau of Foreign and Domestic Commerce, 409 Custom House, New York.

The Bleadon-Dunn Company,—J. J. Bleadon and B. F. Jancke, who have been operating the Bleadon-Dunn Company of 208 North Fifth Avenue, Chicago, Ill., have dissolved partnership and hereafter J. J. Bleadon will continue to carry on the business under the same firm name of Bleadon-Dunn Company. The company has recently moved into larger quarters at 208 North Fifth Avenue. It is manufacturing the "Violetta" high-frequency machine and other electro-medical apparatus.

New Material for Electric Range Elements.—After completing a long series of tests the Globe Stove & Range Company, Kokomo, Ind., has decided upon the adoption of a new material to support the resistance wire used in the heating elements of its electric ranges. The advantages claimed for this material are that it is extremely durable in resisting applications of heat; has ideal qualities for expansion and contraction, and is superior to porcelain as regards toughness and length of life. The material is known as "Pyroplox."

The Magnetic Manufacturing Company, 601 Enterprise Building, Milwaukee, Wis., was recently incorporated under the laws of the State of Wisconsin with a capital stock of $15,000. The company has obtained the exclusive rights to manufacture and sell products formerly brought out by the International Electrical Tool Company. The incorporators of the new company are Alvin Dings, W. Sorgel and Bernhard Kubitz. The officers of the company are: President, George S. Meredith; vice-president, Bernhard Kubitz; second vice-president, W. Sorgel; treasurer, H. P. Andrae, and secretary and general manager, Alvin Dings.

Largest Meter in the World.—A totalizing curve-drawing and integrating wattmeter is being designed by Esterline & Angus and will be built by the Esterline Company for the Keokuk hydroelectric plant of the Mississippi River Power Company. This meter will record the total load curve of the thirty ultimate generators in the station regardless of whether they are operating in synchronism or operating independently. The full scale value of the meter will be 250,000 kw., and it is said that this will be the largest meter of its kind in the world. The plant in which it will be installed is the largest low-head water-power development in the world. It is thought that it will require about six months to conduct the research, to design, to construct and to install this meter.

The National Carbon Company, Cleveland, Ohio, has purchased the plant and business of the Nungesser Carbon & Battery Company, East Forty-eighth Street and King Avenue, Cleveland, and in the future the latter-named concern will be operated as the Nungesser Carbon & Battery Works of the National Carbon Company. Because of his age and bad health, A. B. Foster, president of the Nungesser Carbon & Battery Company, wished to retire and in a large measure this action, it is said, brought about the decision to dispose of the business. Philip P. Nungesser will remain in active charge of the business, under the new ownership. The plant will continue the manufacture of batteries under the Nungesser brand and it is understood that there will be no change whatever in the policy of the concern.

Increasing Demand for Cooling Ponds.—The Spray Engineering Company of Boston, Mass., reports a growing demand for cooling pond equipment, including a recent inquiry for an installation capable of handling 63,000 gal. of water per minute. Recent installations completed or ordered include a 20,000 gal. per minute pond for the Bethlehem Steel Company, South Bethlehem, Pa., for cooling gas-engine jacket water from 200 deg. to 100 deg. Fahr. A 20,000-gal. per minute installation has been made at the Bluestone power station of the recently electrified Norfolk & Western Railroad, and the Aluminum Company of America and the Allis-Chalmers Manufacturing Company have each purchased a 10,000-gal. installation. Air washers of the Spray company's manufacture have just been sold for use in three plants operated by H. M. Byllesby & Company of Chicago. The Spray Engineering Company states that January, February and March business was the best in the history of the concern.

Adaptibility of Electric Trucks.—W. J. McDowell of the General Motors Company, Chicago, has discovered two examples of electric trucks which prove how the electric vehicle can be adapted to widely different fields. Regarding them he says: "We have a record obtained from a department store which last winter used a 1-ton electric truck of modern design. At one time this truck traveled 44 miles in eleven hours. During that time the men operating it delivered 525 packages, which required making 411 separate deliveries, and necessitated making 358 actual stops. If one considers the frightful wear and tear on a reciprocating-engine-driven car making 358 stops, or considers the number of horses which would be required to perform the same work in eleven hours he can readily see that this particular work is exactly in the field of the electric vehicle. On the other hand we have a record of a truck owned by a Chicago brewery which in a whole day's work covers a route of only 9 miles. The operators of this brewery say, however, that this machine is the most economical vehicle in their possession, and they own more than 100 motor trucks, some of which are operated by gasoline and some by electricity. Such a short haul as 9 miles was formerly considered strictly in the field of the horse, but experience in these last few years has demonstrated that fields which were formerly conceded to the horse may be admirably occupied by the electric vehicle."

The Electrollad Company, San Antonio, Tex., has recently been incorporated under the laws of Texas for $50,000. The officers are Richard M. Craig, president; Bascom Bell, first vice-president; A. Elstun, second vice-president, and Charles E. Smith, secretary and treasurer. The company will market the "Electrollad" (meaning electrical roll advertising) which will be built in several sizes. A small "Universal" type machine will probably be built by contract, it is pointed out, and the company states that it will be glad to have various electrical manufacturers bid on it. The larger or outdoor machines will be built by the company, and it will be in the market for various kinds of electrical materials and supplies, including motors with ratings of from 1/30 hp. to ⅛ hp. for building the machines. Nitrogen-filled lamps in considerable numbers will also be utilized in connection with these machines. The machines are designed to carry from five to 100 advertisements, and it is claimed that they will also carry several series of advertisements without interference. The machine can give motion effects, it is claimed, color effects and transparency effects. Each machine is controlled by a roll and is quite compact. Each roll is a separate self-contained unit. The machines are also well adapted for use in carrying out "follow-up" arguments, demonstrating work, showing the processes of manufacture and lecture work and can be employed by traveling salesmen in picture theaters, vaudeville houses, etc.

Orders for Gas Engines for Driving Electrical Apparatus.—The Bruce-Macbeth Engine Company, 2122 Center Street, Cleveland, Ohio, has recently received the following orders for its gas engines for use in driving electrical machines: The Bickett Machine & Manufacturing Company, Cincinnati, Ohio, a 90-hp. four-cylinder vertical engine, directly connected to generator for machine-shop drive; the Corsicana Cotton Mills, Corsicana, Tex., two 250-hp. four-cylinder, vertical engines, directly connected by friction clutches to a 400-kva. Westinghouse alternator and arranged so that either engine or both may be used at one time; the Osborn Manufacturing Company, Cleveland, Ohio, a four-cylinder, vertical 150-hp. engine directly connected to a three-wire, 100-kw. generator; the Columbus Savings & Trust Company, Columbus, Ohio, a 250-hp. four-cylinder vertical gas engine directly connected to a 100-kw. generator and also belted to a three-stage Jeanesville high-duty turbine pump for elevator service; the American Window Glass Company, Jeannette, Pa., one 250-hp., four-cylinder, vertical engine directly connected to a 165-kw. General Electric generator; the American Well & Prospective Company, Corsicana, Tex., one 350-hp. four-cylinder vertical engine, directly connected to a General Electric 400-kva. alternator for use in operating an electric furnace; and the Theodor Kundtz Company, Cleveland, Ohio, a 350-hp. four-cylinder vertical engine directly connected to a 250-kw. Crocker-Wheeler generator.

Electrical Equipment for New Steel Mills.—Among the many new orders for steel mill equipment received by the Westinghouse Electric & Manufacturing Company of East Pittsburgh, Pa., there are three from entirely new plants that illustrate clearly the growth of the steel industry in various parts of the country. The contracts are for the electrical equipment of the following new mills: The Baltimore Sheet & Tin Plate Company of Baltimore, Md., and the Chattanooga Steel Company, Chattanooga, Tenn., and for a new plant being built by the Llewellyn Iron Works at Los Angeles, Cal. The equipment sold to the Baltimore Sheet & Tin Plate Company consists of several large motors for main-roll drive, two 1200-hp. 36-cycle to 60-cycle, 2200-volt, 244-r.p.m., wound-rotor, induction motors, each motor to drive six hot mills equipped with Falk gears and Nuttall flexible couplings, and one 750-hp. 36-cycle to 60-cycle, 2200-volt, 367-r.p.m. wound-rotor, induction motor geared to twelve standard cold rolls. The contract with the Chattanooga Steel Company calls for one 34-in. blooming-mill equipment consisting of an 8000-hp. motor and a flywheel motor-generator set which acts as an equalizer. The equipment sold to the Llewellyn Iron Works for their new plant at Los Angeles, Cal., consists of two 800-hp. 36-cycle to 50-cycle, 2200-volt, 730-r.p.m. to 365-r.p.m., adjustable-speed, wound-rotor, induction motors, the first to drive a 22-in. billet mill, Falk gears and Nuttall flexible couplings being used on this equipment, and the second to be geared to a 12-in. Merchant mill. On this order there is also one 250-hp., 585-r.p.m., 36-cycle to 50-cycle, 2200-volt, wound-rotor, induction motor to be geared to a 14-in. roughing mill.

NEW YORK METAL MARKET PRICES

	April 4 — Selling Prices Bid	Asked	April 11 — Selling Prices Bid	Asked
Copper	£ s d		£ s d	
London, standard spot	116 0 0		120 0 0	
Prime Lake	27.50	to 28.00†	28.25	to 28.75†
Electrolytic	27.50	to 28.00†	28.25	to 28.75†
Casting	26.00	to 26.50†	26.75	to 27.25†
Copper wire base	29.00	to 29.50†	30.00	to 31.00†
Lead	7.50		7.50	
Nickel	45.00	to 50.00	45.00	to 50.00
Sheet zinc, f.o.b. smelter	25.00†		.....	
Spelter	17.92½	to 18.17½	18.92½	to 19.17½
Tin, straits	51.00†		54.50†	
Aluminum, 98 to 99 per cent	57.00	to 59.00†	57.00	to 59.00†

OLD METALS

Heavy copper and wire	21.50	to 22.00†	22.00	to 22.50†
Brass, heavy	13.50	to 14.00†	14.00	to 14.50†
Brass, light	11.00	to 11.50†	11.25	to 11.75†
Lead, heavy	6.65	to 6.87½†	6.65	to 6.87½†
Zinc, new scrap	15.50	to 16.00†	15.50	to 16.00†

*COPPER EXPORTS

Total tons to April 11	7,017

†Nominal

Corporate and Financial

Atlanta (Ga.) Water & Electric Power Company.—A block of $800,000 of first mortgage 5 per cent bonds, due Jan. 1, 1943, is being offered at 99.5 and interest to yield 5.03 per cent.

Carolina Power & Light Company, Raleigh, N. C.—According to the annual report of the company and its subsidiaries, the Yadkin River Power Company and the Asheville Power & Light Company, made substantial progress in increasing their earnings during the year. The increase in the year's gross earnings of the Carolina company was 13 per cent and in net earnings 27 per cent. The increase in the year's gross earnings of the Yadkin River company was 17 per cent and in net earnings 16 per cent. This result, it was stated, was obtained by carrying on an aggressive campaign for new business and by giving careful attention to economies of operation. The additional business was procured without extending the electric transmission lines of the companies. Within a short distance from the present transmission lines are a number of small communities having important industries which afford a further market for the service of the companies. Likewise, in the communities already served it is stated there is excellent opportunity for further extensions of service to cotton mills and other industries not now supplied. The Asheville Power & Light Company was unable to increase its earnings during the year because of somewhat less favorable business conditions in Asheville. During November and December, however, the earnings of the company showed substantial improvement, and it is believed that the increases will be continued. The earnings of the companies for 1915 follow:

CAROLINA POWER & LIGHT COMPANY

	1915	1914
Gross earnings	$701,079	$618,689
Operating expenses and taxes	440,495	412,834
Net earnings	$260,584	$205,855
*Other income	60,000	52,500
Total income	$320,584	$258,355
Interest on bonds	131,300	115,958
Sundry interest and discount (net)	43,712	38,534
Balance after charges	$145,572	$103,863
Preferred stock dividends	56,591	51,384
Balance	$88,981	$52,479

*Dividends on Asheville Power & Light Company common stock.

YADKIN RIVER POWER COMPANY

	1915	1914
Gross earnings	$349,978	$299,606
Operating expenses and taxes	117,127	98,862
Net earnings	$232,851	$200,744
Interest on bonds	175,000	175,000
Other interest (net)	10,359	10,449
Balance	$47,492	$15,295

ASHEVILLE POWER & LIGHT COMPANY

	1915	1914
Gross earnings	$439,267	$443,265
Operating expenses and taxes	242,741	238,468
Net earnings	$196,526	$204,797
Interest charges (net)	52,144	52,607
Balance after charges	$144,382	$152,190
Preferred stock dividends	35,000	35,000
Balance	$109,382	$117,190
Common stock dividends	60,000	52,500
Balance	$49,382	$64,690

Lockport (N. Y.) Light, Heat & Power Company.—The company has been authorized by the Public Service Commission of the Second District of New York to purchase all of the outstanding stock of the International Power & Transmission Company for not to exceed $82,954, consisting of 1500 shares of a par value of $100. Upon the purchase of this stock the Lockport company is required by the commission to charge off the same on its books at the rate of not less than $10,000 a year until the stock is carried at the nominal value of $1, at which rate it must thereafter be carried on the Lockport company's books.

New Jersey Light & Power Company, Dover, N. J.—The company, which has been recently organized, besides acquiring the properties of the Eastern Pennsylvania Power Company at Dover, Rockaway, Bernardsville, Wharton and other sections plans to erect a new power plant at Dover.

North American Company, New York, N. Y.—The annual report of the company for the year ended Dec. 31, 1915, divides the subsidiaries into two groups—the Wisconsin group and the Missouri group. All of the properties comprising the Wisconsin group are controlled by the Wisconsin Edison Company, Inc. The gross earnings of that company for the year amounted to $1,058,396.02, a decrease of $60,808.83, or 5.43 per cent, as compared with 1914. Expenses and interest increased $63,087.22, and net income decreased $123,896.05. Operating revenues of The Milwaukee Electric Railway & Light Company for 1915 amounted to $5,971,715.33, a decrease of $33,780.33, or 0.56 per cent, as compared with the previous year; operating expenses, including taxes and reserves, decreased $67,543.42; interest charges decreased $29,804.85, and net income increased $27,082.65. Operating revenues of the electric light and power department increased $164,995.59, or 8.71 per cent, while the operating revenues of the railway department decreased $198,775.92, or 4.83 per cent. Operating revenues of The Milwaukee Light, Heat & Traction Company for the year amounted to $1,480.625.35, a derease of $13,042.25, or 0.87 per cent, as compared with the previous year. Operating expenses, including taxes and reserves, increased $44,615.29, or 4.72 per cent; interest charges increased $17,589.13, and net income decreased $75,153.96. Operating revenues of the electric light and power department increased $64,240.18, or 11.62 per cent, while the operating revenues of the railway department decreased $77,282.43, or 8.21 per cent. During the year the Wisconsin Gas & Electric Company acquired the Fort Atkinson transmission line of the Milwaukee Light, Heat & Traction Company, and the properties and business of the Watertown Gas & Electric Company and Burlington Electric Light & Power Company. The earnings for the year 1915 accordingly are not directly comparable with those of the company for the preceding year, but the following comparisons may be made of the combined results of operations for the year 1915 with those for 1914 of this company and the properties acquired by it: Operating revenues increased $70,472.50, or 8.13 per cent; operating expenses, including taxes and reserves, increased $37,558.55; interest charges increased $3,791.04, and net income increased $27,202.54. There are now contemplated or in course of construction transmission-line extensions southwestwardly from Fort Atkinson through Whitewater to Elkhorn and Delavan, and southwestwardly from Burlington through Lyons and Lake Geneva Townships, to furnish power to the utilities operating in that territory. These extensions when joined will form a complete loop through the lines of the Milwaukee Light, Heat & Traction Company. Operating revenues of the North Milwaukee Light & Power Company for the year amounted to $14,569.58, a decrease of $239.00, or 1.61 per cent; operating expenses, including taxes and reserves, increased $552.68; interest charges decreased $108.76, and net income decreased $570.38. Increases in revenues from commercial and street contract lighting were more than offset by a decrease in commercial power earnings, due to the shutting down by some of the large factories served by the company. During the months of November and December renewed activity in the industries served by the company was noted. Operating revenues of the Wells Power Company for the year amounted to $187,733.15, an increase of $14,345.64, or 8.27 per cent, over the previous year; operating expenses, including taxes and reserves, increased $4,001.27; interest charges, including interest on notes owned by The Wisconsin Edison Company, increased $15,066.67, and net income decreased $2,302.14. Operating revenues of the Union Electric Light & Power Company for the year 1915 amounted to $3,408,869.47, an increase of $77,476.20, or 2.33 per cent; operating expenses, including taxes and reserves, increased $86,696.15; interest charges increased $36,607.22, and net income decreased $109,008.45. The large decrease in gross income, reflected in decreased net income, is due to a decrease of $126,376.59, or 41.6 per cent, in the revenue derived from the sales of electric energy to the United Railways Company, provided for by contract. Operating revenues of the Electric Company of Missouri for the year 1915 amounted to $1,620-539.08, an increase of $49,660.90, or 3.16 per cent; operating expenses, including taxes and reserves, increased $41,123.17; interest charges increased $7,423.56, and net income decreased $7,163.99.

Operating revenues of the St. Louis County Gas Company for the year 1915 amounted to $263,264.80, an increase of $21,574.20, or 8.93 per cent. Operating revenues of the United Railways Company of St. Louis for the year 1915 amounted to $11,681,200.40, a decrease of $769,724.36, or 6.18 per cent. Gross revenue of the West Kentucky Coal Company for the year amounted to $1,954,198.10, an increase of $236,152.23, or 13.74 per cent. The following is a comparative statement of income and undivided profits for the years 1915 and 1914:

	1915	1914
Interest received or accrued	$488,804	$610,145
Dividends received	1,438,028	1,503,801
Profits and compensation for services	28,671	42,377
	$1,952,503	$2,156,323
Salaries, legal expenses, net rentals and all other expenses of administration	77,780	77,630
Taxes	10,576	24,397
Interest paid or accrued	25,821	140,173
Sundry accounts written off and reserves	33,550	5,351
Total	$147,727	$247,551
Net income	1,804,776	1,908,772
Dividends paid and accrued		
Balance carried to undivided profits account	$315,111	$419,107

Northern States Power Company, Chicago, Ill.—The annual report of the company for 1915 as usual shows in great detail the property back of the company's investment. During the year no dividends were declared on the common stock, the entire surplus earnings of the year having been reinvested in the properties in extensions, improvements, additions and renewals. In addition to the full cost of maintenance, included in the operating expenses and a replacement expenditure of $276,307, the depreciation reserve account was increased from $590,775 to $849,427, and the undistributed surplus from $623,396 to $814,053. The balance sheet shows that the company had $1,040,078 cash in its treasury at the end of the year. H. M. Byllesby, president of the company, states that preliminary steps are being taken to the consolidation of the company's funded indebtedness and the completion of plans for its permanent financing. Toward this end, as it has been previously stated in the ELECTRICAL WORLD, the name of the company's principal subsidiary, the Consumers Power Company of Minnesota, was changed in February, 1916, to Northern States Power Company of Minnesota and its authorized stock increased to balance the authorized stock of the Northern States Power Company of Delaware, the parent concern. During the year, $340,000 of 7 per cent preferred stock has been sold to 480 different stockholders resident in the communities served by the company. Large contracts for the sale of power are being entered into, and anticipating further development, a power contract has been made with the Wisconsin-Minnesota Light & Power Company, which is constructing a water power plant in Wisconsin about 90 miles east of St. Paul. Delivery will begin on Jan. 1, 1917, of approximately 20.000 hp. of primary power on a 40 per cent load-factor basis and a similar amount of secondary power. The contract is for a period of thirty years and at rates which will enable the Northern States Power Company to resell the power on a satisfactory basis. During the year the company spent $2,120,533 on construction account, of which $1,458,466 was at or near Minneapolis. The number of customers served by the company increased from 69,240 to 81,322. In four years the electric connected load has more than doubled. The 1915 output was 186,412,757 kw.-hr. The earnings statement for 1915 and 1914 follows:

	1915	1914
Gross earnings	$5,121,826	$4,395,860
Net earnings	2,866,634	2,364,370
Fixed charges	1,507,938	1,339,668
Balance	$1,358,694	$1,024,702
Preferred stock dividends	587,069	587,069
Balance allocated to depreciation and other reserves and undivided surplus	$771,625	$437,633

Northwestern Ohio Light & Power Company, Van Wert, Ohio.—The Hicksville Electric Light, Heat & Power Company's plant has been acquired by the Northwestern Ohio Light & Power Company, transfer to be made June 1. The plant serves Butler, Edgerton, Spencerville, Antwerp and several other towns in this section, and still further extensions to the company's community service will be made under the new management.

New Utility and Industrial Companies

The Gallipolis Light & Power Company of Gallipolis, Ohio, has been incorporated with a capital stock of $25,000 by John P. Phillips and others.

The Zoar Electric Company of Zoar, Ohio, has been incorporated with a capital stock of $10,000 by John Bimsler, August Bimsler, August Burkhart and others to furnish electricity in Zoar.

The Electric Light & Power Company of Brighton, Ill., has been incorporated with a capital stock of $5,000 to supply electricity for lamps and motors. The incorporators are: Arthur J. Farrell, John A. Bauer and E. Farrell.

The Greensfork Electric Company of Greensfork, Ind., has been incorporated by Henry H. Fagan, Lona Fagan, Elmer N. Ullery and William M. Roller. The company is capitalized at $1,500 and proposes to generate and distribute electricity in Greensfork.

The Interborough Power Company of Spartanburg, S. C., has been granted a charter with a capital stock of $100,000 for the purpose of developing Hill's Shoals on Tyger River, 16 miles south of Spartanburg. The incorporators are: A. M. Law, R. E. Boggs, C. R. Willard and W. G. Willard.

The United Electrical Manufacturing Company of Adrian, Mich., has been incorporated by B. D. Hayes of Detroit, president; Karl F. Wagner of Adrian, secretary; Walter Haley of Adrian, treasurer. The company is capitalized at $50,000 and proposes to manufacture electric horns and apparatus. The company will occupy a portion of the Clough & Warren plant.

The Electric Liquid Operator Company of Jersey City, N. J., has been incorporated with a capital stock of $50,000 for the purpose of acquiring by purchase or otherwise, electrical sign devices, etc. The incorporators are: Albert E. Williams, 382 Webster Avenue; John Blohm, 25 Irving Street and Charles H. Blohm, agent, Palisades Park, all of Jersey City, N. J.

Trade Publications

Electric Pumps.—The Hill Pump Company, Anderson, Ind., has published several folders and bulletins descriptive of its electrically operated house pumps.

Electric Ranges.—The Standard Electric Stove Company, Toledo, Ohio, is sending out a folder printed in colors which contains information on its electrically operated ranges.

Tool Steel.—The Vanadium-Alloys Steel Company, Pittsburgh, Pa., has just issued two folders descriptive of its "Vasco Choice" and "Vasco Non-Shrinkable" grades of tool steel.

Electric Radiators. — The Lee Electric Radiator Company, 319 Wells Street, Chicago, Ill., is sending out a booklet entitled "Electric Radiators and Electric Water Heaters."

Ball Bearings.—"Ball Bearings as an Automobile Sales Factor" is the title of an attractively illustrated catalog issued by the SKF Ball Bearing Company, 50 Church Street, New York.

Transformers.—The Moloney Electric Company, St. Louis, Mo., is sending out an index card which contains information on its transformers and which had been prepared for insertion in purchase files.

Railroad Signal Wire and Cable.—The Hazard Manufacturing Company, Wilkes-Barre, Pa., has recently issued an illustrated booklet which contains information on "Keystone" railroad signal wire and cable.

Stoking Machines.—The Goetz Company, 403 Monadnock Block, Chicago, Ill., has just issued a six-page folder describing and illustrating several installations of its "Ko-Shovel" automatic stoker for small boiler plants.

Condensing Equipment.—The C. H. Wheeler Manufacturing Company, Philadelphia, Pa., has prepared a 179-page illustrated catalog which contains considerable information on various types of condensing equipment.

Oil Burners and Torches.—The Hauck Manufacturing Company, 140 Livingston Street, Brooklyn, N. Y., has just published Bulletin No. 65 which is illustrated and which contains information on various types of oil burners and torches.

Washing Machines.—The Voss Brothers Manufacturing Company, Davenport, Ia., is sending out an attractive catalog which is printed in colors and contains considerable information on various types of electrically operated washing machines.

Electric Vibrators for Foundries.—The Magnetic Manufacturing Company, Enterprise Building, Milwaukee, Wis., has issued illustrated Bulletin No. 5 which describes several types of electrically operated vibrators designed for rapping patterns in foundries.

Electrical Connectors. — The Electrical Engineering & Equipment Company, 522 Wells Building, Milwaukee, Wis., has just issued bulletins No. 56, No. 57 and No. 58 illustrating and describing "Roberson" electrical emergency connectors, meter attachment connectors and straight-on insulated connectors.

Batteries.—The Electric Storage Battery Company, Philadelphia, Pa., has issued Bulletin No. 154 entitled, "The E. S. B. Constant-Voltage Axle-Lighting System" and the first edition of catalog section MS, entitled "The Exide Battery (Miscellaneous Types) for Automobile Starting and Lighting Service."

Switching Apparatus.—"Alternating and Continuous Current Switch Gear" is the title of an attractively illustrated, three-color, large-sized catalog prepared by the British Thomson-Houston Company, Ltd., Rugby, England. The company states that it does not intend to distribute these catalogs broadcast.

Water-Wheel Generator Sets.—An attractively illustrated circular has just been issued jointly by the Pelton Water Wheel Company, San Francisco, and the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., descriptive of the Pelton-Westinghouse water-wheel generator sets and their application.

Electrical Appliances.—The Wisconsin Electric Company, Racine, Wis., has prepared illustrated folders and leaflets on some of its "Dumore" products including a sensitive drill, sewing machine motors, drink mixers, billiard-table cleaner, motor-driven cloth cutter, motor-driven grinder, suction cleaner and "Universal" motors.

Fuses and Line Protective Apparatus.—Schweitzer & Conrad, Inc., Berteau and Ravenswood Avenues, Chicago, have just issued bulletin No. 5 dealing with automatic resistance horn-gap lightning arresters, bulletin No. 1-A which deals with extra-high potential fuses, and bulletin No. 4 which deals with high-capacity primary cut-outs.

Electric Starting, Lighting and Ignition Systems.—The John O. Heinze Company, Springfield, Ohio, is sending out an illustrated bulletin which contains information on its electric starting, lighting and ignition systems for gasoline-operated automobiles. The company has also issued a booklet descriptive of its two-unit systems for Ford cars.

Electrical Protecting Materials.—The Chicago Fuse Manufacturing Company, Chicago, Ill., has prepared Catalog No. 28, which is profusely illustrated and contains 132 pages on various types of protecting materials and stamped steel switch and outlet boxes. The catalog combines under one cover information previously published in several separate catalogs.

Potheads.—The G & W Electric Specialty Company, 7440 South Chicago Avenue, Chicago, Ill., has recently issued Catalog No. 9, entitled "Electric Specialties," which contains considerable information on and illustrations of various types of potheads and other electrical devices. The company has also prepared a supplement to Catalog No. 9, entitled, "Standard Applications of G & W Disconnecting Potheads."

Transmission-Line Material.—The Ohio Brass Company, Mansfield, Ohio, has recently issued Catalog No. 16 which is cloth-bound and contains 654 pages. The catalog is very complete and profusely illustrated and supersedes all other of the company's catalogs with the exception of its valve catalog No. 50. It contains information on a very complete line of appliances used in the construction, maintenance and operation of electric railways, mine-hauling systems and trasmission lines.

New England

SACO, ME.—The York County Power Company has submitted a proposal to the City Council for the installation of an ornamental lighting system (consisting of ornamental standards mounted with four-80-cp. incandescent lamps) in connection with the proposed new street-lighting contract.

SEBEC, ME.—The Milo (Me.) Electric Light & Power Company has applied to the Public Utilities Commission for permission to extend its service to Sebec.

LANCASTER, N. H.—The Jones & Linscott Electric Company of Lancaster has applied to the Public Service Commission for permission to purchase the property of the Lancaster & Jefferson Electric Company of Lancaster, which is now in the hands of a receiver.

BOSTON, MASS.—Bids will be received by the schoolhouse commissioners of the city of Boston, Room 1009, City Hall Annex, Boston, until April 21 for furnishing material for open circuit batteries for department use.

BOSTON, MASS.—Business men and property owners on Canal Street and streets in its vicinity have presented a petition to Mayor Curley, asking for the installation of a better lighting system on that thoroughfare. Joseph F. Sullivan is secretary of the Canal Street Business Men's Association.

NORTHAMPTON, MASS.—The Northampton Electric Lighting Company, it is reported, contemplates the installation of a 2000-kw. turbo-generator set.

SHIRLEY, MASS.—The Shirley Electric Company is now erecting 15 miles of 22,000-volt, three-phase transmission line and is building two sub-stations with new equipment. Thomas E. Whitaker is general manager.

TURNERS FALLS, MASS.—The Franklin Electric Light Company contemplates rebuilding its distribution system in one section of the town jointly with the New England Telephone & Telegraph Company. All material has been purchased. M. H. Mahoney is superintendent.

BRIDGEPORT, CONN.—A permit has been granted for the construction of an addition to the power house (42 ft. by 101 ft.) of the Bridgeport Brass Company on Housatonic Avenue, to cost about $10,000.

BRIDGEPORT, CONN.—The United Illuminating Company of Bridgeport has been awarded the contract for furnishing all small electric lamps for street-lighting. The contract was formerly held by the American Street Lighting Company of Baltimore, Md. The Mayor has signed the resolution extending the ornamental street lamps from State Street to Gilbert Street.

THOMPSONVILLE, CONN.—The Northern Connecticut Light & Power Company of Windsor Locks is preparing plans for the erection of an addition to the local power station.

Middle Atlantic

BROOKLYN, N. Y.—Bids will be received by C. B. J. Snyder, superintendent of school buildings, Department of Education, Park Avenue and Fifty-ninth Street, New York, until April 17, for installing electric equipment in the addition to and alterations in Public School 89 on Newkirk Avenue, between East Thirty-first and East Thirty-second Street, borough of Brooklyn.

BROOKLYN, N. Y.—Bids will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until April 25 for furnishing radial bearings, binnacles, compasses, blowers, electrical cable and wire, hoisting and rotating equipment, outfit for cutting steel, motor-generator sets at the navy yard, Brooklyn. Proposal blanks may be obtained upon application to the above bureau or to the supply officer, navy yard, Brooklyn, N. Y.

CRITTENDEN, N. Y.—The installation of a street-lighting system in Crittenden is under consideration. V. J. Laughlin is chairman of a committee to take charge of the project.

DUNKIRK, N. Y.—The Dunkirk Electric Manufacturing Company is contemplating the purchase of tubes for retubing a 78-in. by 16-ft. boiler.

FRANKLIN, N. Y.—The Franklin & Otsego Light & Power Company contemplates the erection of a transmission line to Sidney Center, a distance of about 4 miles. E. A. Mackey is presiden.

IRONDEQUOIT, N. Y.—The contract for the electric wiring of the Irondequoit sewage disposal plant has been awarded to the O'Connel Electric Company of Rochester, at $11,039.

MEDINA, N. Y.—The A. L. Swett Electric Light & Power Company of Medina has applied to the Public Service Commissioners for permission to issue $700,000 in bonds.

NEW BRIGHTON, N. Y.—The Richmond Light & Railroad Company is installing a new 6000-kw. Westinghouse generator, for which foundations have been laid at the power house at Livingston.

NUNDA, N. Y.—The electric system of the Nunda Casket Company has been taken over by the Nunda Electric Light Company. The capital stock of the company will be increased from $10,000 to $24,000 and the transmission lines extended to Dalton, Hunts and other villages. Energy will be purchased from the Perry (N. Y.) Electric Light Company. The Nunda company will erect a transmission line to connect with the lines of the Perry company at a point about 7 miles from Nunda. A. J. Woodworth is manager.

PARKSVILLE, N. Y.—An electric generator, it is reported, will be installed in the new building to be erected on Main Street by Edwin A. Camden. M. J. Nadel of Newark, N. J., is architect.

PERRYSBURG, N. Y.—The Gowanda Light & Power Company has applied to the Public Service Commission for permission to exercise a franchise in the town of Perrysburg.

RANDOLPH, N. Y.—The Randolph Light & Power Company has applied to the Public Service Commission for permission to exercise franchises in the village of South Dayton and the town of Villenova.

RIPLEY, N. Y.—Application has been made to the Public Service Commission by Alfred Huntington for permission to construct and operate an electric-light plant in Ripley.

ROCHESTER, N. Y.—The Rochester Railway & Light Company has applied to the Public Service Commission for permission to consolidate the properties of the Canandaigua Gas Light Company, the Eastern Monroe Light & Gas Company and the Despatch Heat, Light & Power Company, and also asks for approval of taking over the holdings of the Ontario Light & Traction Company, except its railroad physical property.

SANBORN, N. Y.—Application has been made by the Sanborn-Pekin Power Comuany for permission to erect a transmission line from Sanborn to Pekin. It is proposed to tap the transmission line of the Niagara, Lockport & Ontario Power Company near the Tuscarora Indian reservation, about one mile stare from Sanborn..

SKANEATELES, N. Y.—The Niagara, Lockport & Ontario Power Company of Buffalo has applied to the Public Service Commission for permission to erect a transmisison line into Skaneateles and for approval of franchise.

WATERTOWN, N. Y.—Preparations are being made by the New York Air Brake Company for the construction of two power plants, one to be located at the West Main Street plant and will develop 1200 hp. and the other at the East plant. The contract for the West Main Street plant has been awarded to the Samuel Green Engineering Company of Springfield, Mass. At present the company secures power from the Northern New York Utilities Corporation.

BALA, PA.—Plans have been prepared for the erection of a power plant for the Fred A. Havens Company at Bala. Savery, Scheetz & Savery are architects.

HIGHSPIRE, PA.—The installation of a street-lighting system in Highspire is under consideration by the Borough Council.

MILLERSBURG, PA.—The property of the Millersburg Electric Light, Heat & Power Company has been purchased by Farley Garnett, Telegraph Building, Harrisburg. The new owner, it is understood, will enlarge and remodel the plant.

NEW CASTLE, PA.—An additional $6,000 was placed in the budget for the year to provide for the erection of curb lamp posts in the Long Avenue and Mill Street district.

PHILADELPHIA, PA.—Plans have been approved by a committee of the art jury for the city's power plant at Byberry Farms. Peoples Brothers are contractors.

SCRANTON, PA.—The Scranton Electric Company is contemplating extending its transmisison lines to Canaan and Waymart to supply electricity in those towns from the Carbondale power house. Application has been made for charters for the Canaan Electric Company and the Waymart Electric Company, each to be capitalized at $5,000. Duncan T. Campbell, general manager of the Scranton Electric Company, is treasurer of both companies.

ATLANTIC CITY, N. J.—Preparations are being made by the Atlantic Electric Company to lay a submarine cable under Great Egg Harbor Bay to supply electricity for lamps and motors in Ocean City. The cost is estimated at $75,000.

BAYONNE, N. J.—The Vacuum Oil Company is reported to have awarded a contract for construction of building for the proposed new electric power plant at its refinery.

BRIDGETON, N. J.—The International Electric Light, Heat & Power Company of Philadelphia, Pa., has taken over a number of plants in South Jersey, controlled by the American Railways Company, among which is included the plant of the Bridgeton Electric Company. The merger includes the plants at Wenonah, Woodbury, Pitman, Glassboro, Salem and Pennsgrove. The output of the local plant will be greatly increased as Bridgeton will be the central distributing point for South Jersey. Orders, it is understood, have been placed for the necessary machinery. B. Frank Hires of Bridgeton has been appointed general manager for the South Jersey Division.

TRENTON, N. J.—Plans are being prepared by the Trenton Water Power Company for the construction of a hydroelectric power plant on Assunpink Creek.

TRENTON, N. J.—The City Commission is planning for the installation of a new street-lighting system on State, Broad and Warren Streets, as provided for in a recent bill signed by the Governor.

TRENTON, N. J.—The Public Service Electric Company is planning to erect a new transmission line to Hightstown to furnish energy to the Electric Light & Power Company of Hightstown. The latter company will make extensions to its plant in Hightstown.

WILMINGTON, DEL.—The National Properties Companies of New York, N. Y., has placed a contract with the General Electric Company for an additional turbo-generating unit, with necessary boilers and accessories, to be installed at the plant of the Wilmington & Philadelphia Traction Company. This unit will increase the output of the plant by 50 per cent.

BALTIMORE, MD.—The Consolidated Gas, Electric Light & Power Company of Baltimore has placed an order for a new 26,000-hp. unit for its Westport plant. E. D. Edmondston is general superintendent.

BEL-AIR, MD.—The Bel-Air Electric Company contemplates the erection of 11 miles of three-phase transmission line to reach new territory and to connect with an auxiliary source of supply of energy for peak load and for emergency service. H. S. O'Neill is superintendent.

ST. MICHAELS, MD.—The installation of a municipal electric-light plant in St. Michaels is reported to be under consideration.

ST. MARY'S, W. VA.—The local electric-light system has been purchased by Ernest Mallory of Parkersburgh. The new owner, it is understood, will conduct an ice and cold storage plant in connection with the electric plant.

RICHMOND, VA.—Bids will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until May 3 for a ventilating apparatus, plumbing, etc., for the United States post office and court house at Richmond, Va. For details see proposal columns.

North Central

DETROIT, MICH.—A corporation capitalized at $1,000,000, it is reported, has been organized to construct an electric railway from Dearborn to Highland Park, with a view of connecting the Ford plants, the motor car factory in Highland Park and the tractor factory planned for Dearborn and to furnish transit service between Michigan, Grand River, Hamilton and Woodward lines. Robert Oakman, Mayor Oscar B. Marx, L. W. Tuller, and others, are interested in the company.

LAWRENCE, MICH.—A special election will soon be called to submit to the voters the proposal to establish a municipal electric-light plant in Lawrence.

MONROE, MICH.—At an election held April 3 the proposal to issue $90,000 in bonds for the installation of a new municipal electric-light plant was carried.

MONROE, MICH.—The Monroe Steel Casting Company has offered to enter into a contract with the city of Monroe for electricity for a period of five years. The

Construction

News of Projects, Plans, Bids and Contracts. Notes on Work Under Way

company would require about 400 kw. per hour.

SAULT STE. MARIE, MICH.—Contract has been awarded by the Michigan Northern Power Company to the Underpinning & Foundation Company of New York, N. Y., for a trial section of the re-enforcement of the power house of the power company. If preliminary operations prove satisfactory and it is decided to re-enforce the entire power house, it will mean an additional output of approximately 30 per cent, using the same amount of water as at present. This additional power capacity will, however enable the company to secure additional water rights from the government, so that eventually the 19,000 hp. now being developed will be increased 30 per cent.

SMYRNA, MICH.—The dam of the Spencer Electric Light & Power Company of Belden, located on Flat River in Smyrna, was carried away on March 29. A temporary dam will be built at once to supply power until plans can be prepared for a reinforced concrete dam. The company would like to correspond with contractors, etc., interested. W. P. Hetherington is secretary of the company and J. E. Stanton is superintendent.

BARBERTON, OHIO.—R. E. Long, superintendent of the municipal electric plant, has submitted a report to the City Council recommending new equipment for the plant, involving an expenditure of about $43,000. An addition will be necessary to the power house to provide space for new machinery.

CANFIELD, OHIO.—The Citizens' Union is negotiating with the Mahoning & Shenango Railway & Light Company of Youngstown to extend its electric transmission line from Cornersburg to Canfield to supply electrical service here.

CANTON, OHIO.—Service Director McClaskey has been instructed to advertise for lighting the city (with both gas and electricity).

CANTON, OHIO.—The Canton Electric Company will soon begin the erection of a storage building and machine shops, in Canton, to cost about $50,000.

CANTON, OHIO.—The Central Electric Company of Canton, it is reported, is contemplating the erection of a high-tension transmission line to Fostoria, Tiffin, Newark and other Ohio cities, involving an expenditure of about $2,000,000.

CLEVELAND, OHIO.—Bids will be received at the office of the commissioner of purchases and supplies, City Hall, Cleveland, until April 25 for engine and turbine automatic control oiling and filter systems for the Division Avenue pumping station. Specifications may be obtained at the office of the deputy water commissioner of water, 413 Superior Avenue, City Hall.

DESHLER, OHIO.—The Town Council is considering the question of installing an electric-light plant and water-works system in Deshler.

HICKSVILLE, OHIO.—The property of the Hicksville Electric Light, Heat & Power Company has been acquired by the Northwestern Ohio Light & Power Company of Van Wert, the transfer to be made June 1. The plant serves Butler, Edgerton, Spencerville, Antwerp and several towns in this vicinity. Further extensions will be made by the new management.

KENT, OHIO.—The Kent Water & Light Company is negotiating with the City Council for improvements to the street-lighting system which provide for the installation of new lamps in the business section and the erection of 400 bracket lamps in the residential districts. The company offers additional facilities as an alternative to the proposed municipal electric-light plant.

WEST CARROLLTON, OHIO.—Plans prepared by the Cleveland Construction Company, Citizens Building, Cleveland, for electrical machinery for the plant of the Miami Paper Company, provide for a 1500-kw. General Electric turbine (already purchased); four 200-kw. motors will be installed to operate Jordans and five 100-kw. motors to operate the heaters; four constant speed motors will also be installed to operate paper machines. A new power house is to be erected and exhaust steam will be used in the paper-making process.

YOUNGSTOWN, OHIO.—Bids will soon be asked, it is reported, by John S. Lewis of the water-works department, on two 15,000,000-gal. electrically-driven centrifugal pumps for filter bed water supply and one 4,000,000-gal. pump for water wash, the latter to furnish water to wash filtering basin.

CYNTHIANA, KY.—The installation of a municipal electric-lighting plant in Cynthiana is under consideration. The contract with the Kentucky Utilities will soon expire.

ELKTON, KY.—The Kentucky Power Company of Pembroke has taken an option on the local electric-lighting plant, owned by Charles C. Damon.

HAZARD, KY.—The Kentucky Power Company, it is reported, will ask for bids about May 1 for the construction of a power plant in Hazard. Equipment for proposed plant has been purchased. H. W. Saunders of Welch, W. Va., is chief engineer.

HORSE CAVE, KY.—The Horse Cave Ice Company and the Horse Cave Light Company have been consolidated under the name of the Horse Cave Light & Ice Company with a capital stock of $25,000. The incoprporators are: J. P. Todd of Elizabethtown, Ky.; C. F. Smith, W. C. Davis and L. Hawkins of Horse Cave.

LEXINGTON, KY.—Plans are being considered by the City Council for the installation of a municipal electric-light plant. J. W. Guyn is city engineer.

CARTHAGE, IND.—T. F. Brenan, owner of the local electric-light plant, has recently finished the installation of a 100-hp. boiler and steam engine and will need a 60-cycle, 2200-volt generator of about 30 kw. capacity.

COLUMBUS, IND.—The installation of an electric-lighting system is under consideration by the citizens of East Columbus, a suburb of Columbus. The Social Center Club is behind the movement.

CRAWFORDSVILLE, IND.—Local business men have petitioned the City Council to purchase a new generator for the municipal electric light plant in order to provide for increasing demand for electricity for manufacturing purposes in Crawfordsville.

ELKHART, IND.—Work, it is understood, will soon begin on construction of new power house for the New York Central Railroad Company's shops in Elkhart, to cost about $20,000.

ELWOOD, IND.—The Indiana General Service Company of Elwood is now installing 39 additional 4-amp., magnetite arc lamps and 17 multiple incandescent alley lamps of 100 cp. O. E. Haldeman is superintendent.

INDIANAPOLIS, IND.—The Merchants Heat & Light Company of Indianapolis, it

Hydroelectric Development of the Central Power Company on the Middle Loup River in Nebraska

The hydroelectric development of the Central Power Company of Grand Island, Neb., on the Middle Loup River, is of especial interest owing to the fact that it is the first water power of any size to be developed in the State. The dam is a concrete structure carried on piles, since the foundation is largely sand to a depth of at least 100 ft. The length of the dam over all is 523 ft., and opening from it is a sluiceway on the south end measuring 62 ft. and consisting of four openings. From the foundation line to the top of the concrete portion the dam is 10 ft. in height. The accompanying illustrations show the cofferdam for power house No. 2 foundation work and the water turbines being installed. The power house, which is built largely of reinforced concrete, is in two distinct parts. The part nearest the South Loop River, which houses generators and electrical equipment, is 46 ft. wide facing the river, and 30 ft. deep toward the canal. The other portion of the building, which is on the canal side, consists of two flumes or wheelpits each 20 ft. wide, 50 ft. long and varying in depth from 18 ft. to 25 ft. In each flume is mounted a turbine of the horizontal type, 42 in. in diameter, and capable of developing 1500 hp. Thus 1250 kva. is developed at each generator, or a total of 2500 kva. for the plant. Each unit carries its own exciter, directly connected. There is also a 50-kw. motor-driven exciter sufficient to excite both generators. In the generating room are placed three 750-kva., 2300/33,000-volt, water-cooled transformers to step up energy from the generator voltage to high-tension voltage. All connections between generators, switchboard and transformers are in lead-covered cables carried in the floor in 3½-in conduit. The switchboard consists of seven panels, among which are, besides the ordinary generator panels, the high-tension control panel, the small feeder panels and a control panel for the auxiliary plant, which will be built on the South Loop River below the main power house. Here a fall of about 10 ft. is available by making an 800-ft. cut through a bend in the river, and a 500-kva. generating unit will be installed to take advantage of this drop. This generator set will be floated on the line without a governor or a special attendant. Making the cut mentioned will take the river about a half a mile from the power house and will relieve the latter of all difficulties due to flood waters in the tail race. The machinery, which is now on the ground, will be put in place as fast as practicable.

The wheel housings are partially erected and the wheels can be put in place in a very short time when the weather permits. The L. E. Myers Company, Monadnock Building, Chicago, Ill., has charge of the construction work. T. H. Fritts of Grand Island is vice-president of the Central Power Company.

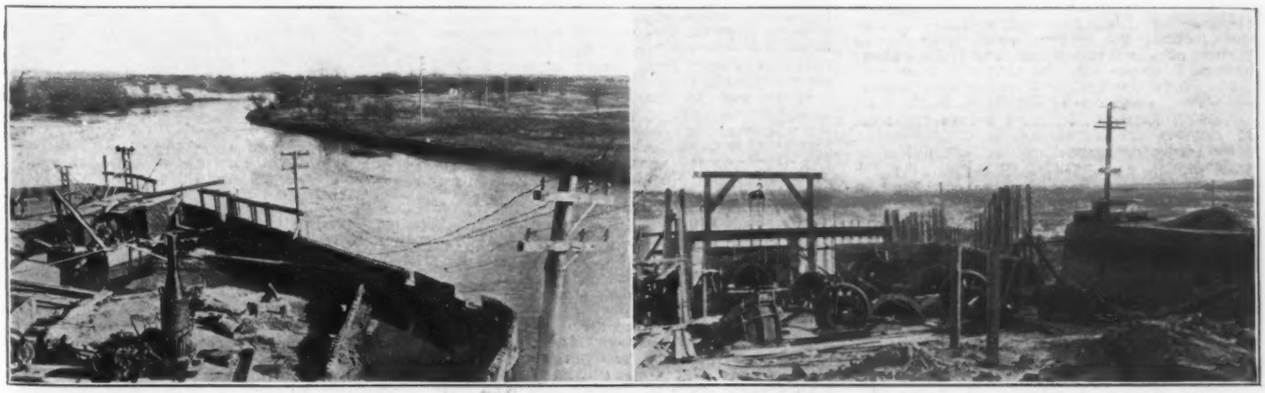


FIG. 1—COFFERDAM FOR POWER HOUSE NO. 2, FOUNDATION WORK, CENTRAL POWER COMPANY, GRAND ISLAND, NEB.; FIG. 2—WATER TURBINES BEING INSTALLED IN POWER HOUSE NO. 2

is announced, will soon begin alterations and additions to its plants involving an expenditure of about $280,000. The work will include a new 300-ft. brick stack at the West Washington Street plant, the installation of new boilers, engines and stokers and new brick work for new equipment. Changes will also be made to the plant on Pearl Street and to the stations on Alabama Street, Court Street and Talbott Avenue. At the east plant two engines will be replaced with a new turbine. A new 1500-kw. rotary converter will be installed at the Court Street station. A. W. Higgins is general manager.

MOUNT VERNON, IND.—The installation of an ornamental lighting system in the business district is under consideration by the City Council and business men.

SHELBYVILLE, IND.—The Manufacturers' Association has appointed a committee to investigate the feasibility of installing an electric-light and power plant in Shelbyville.

DIXON, ILL.—The Illinois Northern Utilities Company is planning to erect a transmission line from Tampico to Walnut and Ohio during the coming summer, to furnish electrical service in those towns.

GRANITE CITY, ILL.—The Madison County Light & Power Company of Granite City expects to change the voltage on transmission line from 17,000 to 33,000, install new transformers at power house in Venice and at Edwardsville; also to install induction feeder regulators on Granite City circuit and increase size of feeders. E. D. Bell is general superintendent.

HOMER, ILL.—The property of the Homer Electric Light & Power Company has been purchased by the William B. McKinley interests of Champaign. The local plant, it is understood, will be closed down and electricity secured from the transmission lines of the Illinois Traction Company.

JOLIET, ILL.—The Public Service of Northern Illinois has been granted a franchise to supply electricity for lamps and motors in Romeoville and a ten-year contract for street lighting.

JOLIET, ILL.—Bids will be received at the office of the school board of inspectors, Public Library Building, Joliet, until April 24, for construction of new grade school building, known as F. E. Marsh School. Separate bids to be submitted as follows: For general construction work; heating and ventilating and heat regulation; plumbing, sewering and gas fitting; electric wiring; clock, gong and fire-signal systems. Drawings and specifications may be seen at the office of the board and at the office of John D. Chubb, architect, 109 North Dearborn Street, Chicago.

SALEM, ILL.—A new 200-kw. generating unit (directly connected), consisting of a Westinghouse generator and Ball engine, is now being installed in the municipal electric-light plant. No line work is being done at present, but the city contemplates changing the entire system. Two new boilers are needed for the plant. W. F. Hines is superintendent.

SHABBONA, ILL.—The installation of an electric-lighting system in Shabbona is under consideration.

WEST FRANKFORT, ILL.—Preliminary arrangements have been made for the construction of the new Schott electric line to connect Harrisburg, Marion, Johnston City, Benton and West Frankfort, work on which, it is understood, will soon begin.

WHITE HALL, ILL.—At an election to be held on April 18 the proposal to issue $20,000 in bonds for the installation of a municipal electric-light plant will be submitted to the voters.

RACINE, WIS.—The Milwaukee Electric Railway & Light Company contemplates the erection of a boiler house, three stories high, on Lake Avenue and will install three boilers.

SHARON, WIS.—The municipal water, gas and electric plant was damaged by an explosion recently, causing a loss of about $10,000.

SHAWANO, WIS.—The bids submitted March 28 to the Electric Light and Water Works Commissioners for the construction of concrete dam, power house and earth dikes have not been opened. Contract may not be awarded until May. The Power Engineering Company, Corn Exchange Building, Minneapolis, Minn., is engineer.

BARRETT, MINN.—The village of Barrett has engaged Earl D. Jackson, consulting engineer, Capitol Bank Building, St. Paul, to prepare plans for the installation of an electric-light system here. A transmission line will be erected from Barrett to Elbow Lake.

FERGUS FALLS, MINN.—The Otter Tail Power Company of Fergus Falls is contemplating extending its transmission lines to Wilmot this summer.

GAYLORD, MINN.—Bids will be received by Fred Hoppenstedt, county auditor, Gaylord, until May 1, for general plumbing, heating, electric wiring and furniture contracts for court house, sheriff's residence and jail for Sibley County. Plans and specifications may be seen at the Builders' Exchanges of Chicago, Ill.; Duluth, St. Paul and Minneapolis, Minn., or copies may be obtained from Burner & Macomber, architects, McKnight Building, Minneapolis.

HARTLAND, MINN.—The proposal to install a municipal electric-lighting system in Hartland has been approved by the voters.

ROCHESTER, MINN.—The city of Rochester has engaged Hugh L. Copper, consulting engineer, 101 Park Avenue, New York, N. Y., to make an examination of the Zumbro water power proposition. Bonds to the amount of $360,000 have recently been voted for construction of a hydroelectric plant near Zumbro Falls.

THIEF RIVER FALLS, MINN.—An election will soon be held to vote on the proposal to issue $30,000 in bonds for improvements to water and lighting systems.

WENTWORTH, MINN.—The installation of an electric-lighting system in Wentworth is under consideration.

ADAIR, IOWA.—Negotiations have been completed by the City Council for the sale of the municipal electric-light plant to John A. Reed, for $12,500. The proposition will be submitted to the voters on April 24.

ARION, IOWA.—The installation of an electric-lighting plant in Arion is under consideration. It is proposed to install a water wheel at an old flour mill in the town.

ARMSTRONG, IOWA.—The Armstrong Cement Works, which owns the local electri-light plant, is contemplating extending its transmission lines to furnish electrical service in Ringstad.

BELLE PLAINE, IOWA.—The Iowa Railway & Light Company is erecting a high-tension transmission line from Tama to Blairstown. All material has been purchased. M. W. B. Seely is local manager.

BURLINGTON, IOWA.—Preparations are being made by the Buruington Railway & Light Company to erect a 45-mile electric transmission line to connect power plant in Des Moines and Louisa Counties with Burlington.

IMOGENE, IOWA.—Bids will be received at the office of F. J. Wiman, town clerk, Imogene, until May 1, for furnishing material and installing an electric-lighting system in the village of Imogene. For details see proposal columns.

PERRY, IOWA.—Plans have been completed by the Iowa Railway & Light Company of Cedar Rapids for the construction of a new power plant in Perry, to cost about $100,000. The plant when completed will supply electricity in the towns of Rippey, Grand Junction, Dana, Paton, Woodward, Coon Rapids and other towns in this vicinity.

VINTON, IOWA.—The Council has decided to call a special election to be held April 18 to submit to the voters the proposal to issue $15,000 in bonds for improvements to electric plant and water-works system.

WAVERLY, IOWA.—A short addition to distribution lines will be made this season and a few electroliers will be erected on Main Street, which have already been purchased. H. R. Van Deveer is city clerk.

BRANSON, MO.—Plans has been prepared by the Ozark Water & Power Company, it is reported, for improvements to its system, involving an expenditure of about $300,000. The company furnishes energy in Joplin and Springfield and other cities in Southwest Missouri.

EMMA, MO.—The Council has contracted with the city of Sweet Springs to supply electricity in Emma from its municipal electric plant.

HURLEY, MO.—The installation of an electric-light plant in Hurley is reported to be under consideration. J. H. Whinnery and D. C. Likins are interested.

ROCKVILLE, MO.—The installation of an electric-lighting plant in Rockville is under consideration.

HAZELTON, N. D.—The installation of additional equipment in the local electric-light plant is reported to be under consideration.

MARMOUTH, N. D.—A franchise has been granted to W. R. McKenzie, president of the Bowman Electric Light & Power Company, to install and operate an electric-light and power plant in Marmouth for a period of 25 years. The company was also given a contract for lighting the village, which calls for thirty-seven 100-watt and twenty-four 40-watt street-lamps.

SIOUX FALLS, S. D.—A petition has been submitted to the City Commissioners asking that the proposal to issue $700,000 in bonds, of which $350,000 is to be used for acquiring and operating an electric-light plant and the remainder for a gas plant, to be submitted to the voters at the next regular election.

FLORENCE, NEB.—The City Council has called an election to be held April 18 to submit to the voters the proposal to issue $10,000 in bonds for the installation of a municipal electric-light system. It is proposed to secure energy to operate the plant from the Metropolitan water plant in Florence.

KEARNEY, NEB.—The Kearney Water & Electric Power Company has applied to the State Railroad Commission for permission to issue $230,000 in bonds.

PALMYRA, NEB.—The proposal to install an electric-lighting system in Palmyra will soon be submitted to the voters.

STELLA, NEB.—The engine in the local electric-light plant was wrecked recently, putting the plant out of commission.

ASSARIA, KAN.—The Assaria Light & Power Company, recently organized with a capital stock of $3,000, proposes to furnish electrical service here.

CLAY CENTRE, KAN.—The Public Utilities Commission expects to install a 300-kva. generating unit, directly connected, either high-speed, cross compound Corliss or unaflow engines, this summer. C. F. Rasmussen is superintendent.

EASTON, KAN.—The citizens on April 18 will vote on the proposal to issue $6,000 in bonds for the installation of an electric-lighting system.

GARDEN CITY, KAN.—Negotiations are under way, it is reported, whereby the plant of the Garden City Telephone, Light & Manufacturing Company, recently damaged by fire, will be taken by the city and operated in connection with the municipal electric plant. If the deal goes through a transmission line will be erected to connect the two stations.

LEWIS, KAN.—The Kinsley (Kan.) Electric Light & Power Company is contemplating extending its transmission line from Kinsley to Lewis to supply electricity here.

PRATT, KAN.—Bonds to the amount of $23,000 have been voted, the proceeds to be used to purchase the local electric-light plant.

SOUTH HAVEN, KAN.—Improvements are being made to the municipal electric-light plant, including the installation of a 35-hp. Foos oil engine, Westinghouse generator, exciter and switchboard. J. R. Britton is engineer.

SYLVIA, KAN.—Bonds to the amount of $5,000 have been authorized for the installation of a distribution system in Sylvia and the erection of a transmission line from Stafford.

YATES CENTER, KAN.—At an election held recently the proposal to issue $20,000 in bonds for a municipal electric-light plant was defeated.

Southern States

HIGH POINT, N. C.—The City Council is considering the installation of an electric generating plant. The city now purchases electricity from the North Carolina Public Service Company. As yet no definite steps have been taken.

RALEIGH, N. C.—Preparations are being made for the installation of an ornamental lighting system, to cost about $34,000. The plans provide for ornamental standards mounted with a 500-cp. magnetite arc lamp. Overhead wires, poles, etc., are to be removed from the "White Way" district by May 15. Joseph E. Pogue is chairman of the committee.

RANDLEMAN, N. C.—The Randleman Power Company is contemplating the erection of a few thousand feet of additional lines. N. F. Farlow is manager.

NINETY SIX, S. C.—Bonds to the amount of $15,000 have been voted for the installation of an electric-lighting system. It is proposed to erect a transmission line, about 1 mile long, to connect with the high-tensions lines of the Southern Power Company of Charlotte, N. C.

SUMMERTON, S. C.—Plans are being prepared, it is reported, to rebuild the local electric-light plant, which was recently destroyed by fire.

ATLANTA, GA.—The City Council has authorized the installation of 100 ornamental lamp posts in Piedmont Park. The Georgia Railway & Power Company will install the lamps.

METTER, GA.—Bonds to the amount of $8,500 have been voted for the construction of a municipal electric-light plant.

LAKELAND, FLA.—Contract for construction of power house, reservoir and equipment for electric plant and waterworks system, including conduit and wiring and piping, etc., is reported to have been awarded to the Southern Construction Company of Jacksonville, at $25,340.

LAKE HAMILTON, FLA.—The Electric Company of Bartow has been granted a franchise to install an electric-lighting system in Lake Hamilton. E. C. Stuart of Bartow is president of the company.

TAVARES, FLA.—A franchise has been granted to W. F. L. Barrett of Houghton, Mich., for installation of an electric-lighting system, water-works, ice factory and cold-storage plant.

COVINGTON, TENN.—Steps have been taken by Richard H. Green of Covington to organize a company to construct and operate a hydroelectric power plant.

ETOWAH, TENN.—The Etowah Water & Light Company is installing a 50-kva., 12,000-volt step-down transformer for the Etowah station. W. H. Price is manager.

HARRIMAN, TENN.—Rights of way have practically been secured by the Dayton Light & Power Company, a subsidiary of the Tennessee Power Company, which owns the Rockwood power plant, for the erection of a transmission line into the city.

HUNTINGTON, TENN.—The installation of a 30-kw., three-phase generator in the power house and establishing a 24-hour service is under consideration by the City Council. All flat rate service is being discontinued and all customers are to be served at meter rates. J. M. Dill is manager.

JACKSON, TENN.—Improvements including the construction of a power plant are being made by the Illinois Central Railroad Company in Jackson. The cost of the work is estimated at $200,000.

NIOTA, TENN.—Plans are being considered by the Niota Water Company for the installation of an electric-lighting plant.

DECATUR, ALA.—Plans submitted by Xavier A. Kramer, consulting engineer of Magnolia, Miss., place the cost of a municipal electric plant at $28,000, and distribution system, etc., at $16,000. It is expected that the proposal to issue $50,000 in bonds to construct the plant will be submitted to the voters.

BALDWYN, MISS.—Bonds to the amount of $10,000 have been voted to install an electric-light plant and for improvements to water-works system.

ADA, OKLA.—One of the engines and a generator in the plant of the Ada Electric & Gas Company was destroyed recently, causing a loss of about $8,000.

BLACKWELL, OKLA.—The proposal to issue $10,000 in bonds for extension to electric-lighting system will be submitted to the voters on April 19. The Benham Engineering Company of Oklahoma City is engineer.

CHICKASHA, OKLA.—The Chickasha Gas & Electric Company is planning to erect a transmission line to Verden, a distance of 10 miles, where it was recently granted a franchise to supply electricity.

PADEN, OKLA.—The Paden Light & Power Company is contemplating the installation of an electric-light plant, to cost about $10,000. Contracts, it is understood, have been placed for machinery.

BIG SANDY, TEX.—The Big Sandy Electric Light Company is reported to have purchased a site and will remove its plant and make improvements to the system.

DALLAS, TEX.—At an election held recently the proposal to issue $500,000 in bonds for the installation of a municipal electric-light plant was defeated.

DENTON, TEX.—Extensions will be made to the municipal ornamental street-lighting system.

MAGDALENA, TEX.—The electric plant of the Magdalena Electric Light Company was recently purchased (at a receiver's sale) by George Keith and E. Wayne of Socorro. The new owners, it is understood, will make improvements to the plant.

Pacific States

OAKVILLE, WASH.—The City Council has decided not to purchase the electric plant, owned by the Oakville Light & Power Company.

OLYMPIA, WASH.—The city attorney has filed ordinaces with the city clerk cancelling the three franchises given to Wilbur B. Forshay of Portland, Ore. Mr. Forshay was given an electric-lighting and steam heating franchise, together with a contract to sell electricity to the city.

SEATTLE, WASH.—The Western Water Power Company of Everett has submitted a proposal to the City Council offering to develop the Deer Creek-Lake Kavanaugh power project and sell it to the city of Seattle. The City Council, it is reported, has taken the matter under advisement and will consider the offer with the other projects, including that on the Sauk and Suiattle rivers. The transmission distance from the power plant of the Western Water Power Company to Seattle is about 70 miles. The company is controlled by Rucker Brothers, lumbermen, of Everett.

SPOKANE, WASH.—The Constitution Mining & Milling Company, it is reported, contemplates the construction of an electrolytic plant in Spokane for the treatment of zinc ores, capable of handling 100 tons a day, at a cost of about $425,000. The proposed plant, it is estimated would use about 6000 hp.

PENDLETON, ORE.—Plans are being prepared for the construction of an electric railway from Pendleton to Walla Walla, Wash., and from Cold Spring Landing through Pendleton to Bingham Springs. C. W. Lefler and E. W. McComas of Pendleton are interested in the project.

FRESNO, CAL.—Work will soon be started on construction of a power station below Crane Valley, for the San Joaquin Light & Power Company of Fresno, to cost about $500,000. The new plant will be known as power house No. 2, and will be located 1½ miles south of North Fork and will utilize the fall of water between the two present plants. Machinery for a 3000-kw. plant has been ordered.

LOS ANGELES, CAL.—Bids will be received by H. J. Leland, clerk of Board of Supervisors of Los Angeles until April 24, for furnishing and installing water tube boilers in the county hospital power house.

LOS ANGELES, CAL.—Bids will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until May 8 for a vacuum cleaning machine for the United States post office and court house at Los Angeles, Cal. for details see proposal columns.

MADERA, CAL.—Extensions are being made by the San Joan Light & Power Company of Fresno in Raymond, Knowles and Coarse Gold districts of Madera County, involving an expenditure of about $20,000. Two new substations are being erected by the company, one at Knowles and the other at Coarse Gold; each station will handle 30,000 volts. The station at Coarse Gold will supply electricity for operating the mines, and, it is expected, in the near future, will also serve the town of Coarse Gold. The Knowles substation will serve the quarries and the town of Raymond.

SEAL BEACH, CAL.—The Trustees of Seal Beach have signed a contract with the Southern California Edison Company of Los Angeles for the installation of an electric street-lighting system. The contract is for a period of five years and provides 50 lamps of 600 cp.

TURLOCK, CAL.—A preliminary estimate has been submitted to the Turlock Irrigation Board by Engineer Meikle for developing power in the district for drainage purposes, which places the cost at $169,000.

GRAND VIEW, IDAHO.—The Utah Power & Light Company of Provo, Utah, is erecting an electric transmission line into Grand View.

ROBERTS, IDAHO.—The Public Utilities Commission has granted the Utah Power & Light Company of Provo. Utah, permission to extend its transmission lines to Roberts.

TWIN FALLS, IDAHO.—J. M. Burkett, engineer, recommends to the City Council the construction of a rock-filled dam with cement concrete core in preference to either a steel bridge or a simple rock filled dam for the proposed power plant for the city. The cost is estimated at $10,000.

WALLACE, IDAHO.—The City Council has granted the Washington Water Power Company of Spokane permission to erect transmission lines through the streets and alleys of Wallace to enable the company to supply energy to the several mining properties under development on Placer Creek.

MIDVALE, UTAH.—The County Commissioners have granted the Utah Power & Light Company permission to extend its transmission line from Midvale to the West Jordan district to supply energy for lamps and motors to the new sugar factory and also to the residents in that district.

OGDEN, UTAH.—Preparations are being made by the Ogden, Logan & Idaho Railway Company of Ogden to construct a new railway between Utah Hot Springs and Brigham City, 13 miles long, this summer.

SALT LAKE CITY, UTAH.—The State Board of Corrections has decided to light the State Prison yard and grounds by the flood-light system, and has authorized Arthur Pratt, warden, to make the change at once.

SALT LAKE CITY, UTAH.—The Utah Power & Light Company has taken over what is known as the church power plant, which supplies electricity for the Temple Block, the Hotel Utah, Desert News Building and several business blocks in the immediate vicinity. The plant was purchased from the Mormon Church and will hereafter be operated by the corporation.

SALT LAKE CITY, UTAH.—The contract for lighting the new State capitol grounds has been awarded to Eardley Brothers, Salt Lake City, at $9,500. The contract calls for 74 ornamental standards, 12 of which will be mounted with five-lamp clusters, the others with a single lamp of 250 cp. At present the commission does not contemplate the flood-lighting of the capitol building at night.

SHUMWAY, ARIZ.—The installation of an electric plant to supply electricity in the towns of Snowflake and Taylor and Shumway, is reported to be under consideration by R. C. Smith.

TUCSON, ARIZ.—Bids will be received by the Board of Regents of the University of Arizona for equipment for a central power and heating plant. For details see proposal columns.

TUCSON, ARIZ.—Plans are being considered for the construction of a central power and heating plant at the School of Mines of the University of Arizona, to cost, including equipment, about $95,000. An engineering building, to cost about $175,000, will also be erected soon. Both to be built by day labor. R. S. King is superintendent of construction.

ANACONDA, MONT.—Preliminary plans for the construction of a 20 ft. by 200 ft. concrete wall across the gulch at the edge of the city to form a small reservoir, which will not only control the flood waters, but furnish power for a proposed municipal electric-light plant, has been completed by the city engineering department. The cost is estimated at $25,000.

FROID, MONT.—The installation of an electric-lighting system in Froid is under consideration. Sidney J. Dorothy and M. J. Kochendorfer are reported interested.

SCOBEY, MONT.—Application has been made to the Town Council for a franchise to install an electric-light system in Scobey.

Canada

EDMONTON, ALTA.—Provision has been made by the Department of Public Works for telephone construction in the Province of Alberta, to cost about $250,000. C. Stewart of Edmonton is minister of public works.

SASKATOON, SASK.—A small extension to the municipal power house is contemplated to accommodate a new electrically controlled switchboard supplied by the Northern Electric Company; also one rotary converter, supplied by Ferranti. Tenders for the necessary cable will be called for in about two weeks. E. Hanson is city electrical engineer.

LYNDHURST, ONT.—The erection of a transmisison line from Lyndhurst to Delta, a distance of 5 miles, is contemplated by G. E. Roddick. Transformers and No. 6 copper wire will be required.

BAIE, S. PAUL, QUE.—The Baie St. Paul Electric Company has just completed 1150 ft. of penstock and repairs to dam, and it intends to make a change in grade of penstock. E. Tremblay is superintendent.

Miscellaneous

PANAMA.—Bids will be received at the office of the assistant purchasing officer, 24 State Street, New York, N. Y., until April 22 for the purchase of transformers offered for sale by the Panama Canal. For details see proposal columns.

PANAMA.—Bids will be received at the office of the general purchasing officer, the Panama Canal, Washington, D. C., until April 26 for boiler tubes, sheet copper, copper nails, twist drills, electric cable, wire, transformers, watt-hour meters, electric switches, electrical attachments, magnesia pipe covering, etc. Blanks and general information relating to this circular (No. 1031) may be obtained from the above office or the offices of the assistant purchasing agents, 24 State Street, New York, N. Y.; 614 Whitney-Central Building, New Orleans La., and Fort Mason, San Francisco, Cal.

1,177,617. SOUND MUFFLER ATTACHMENT FOR TELEPHONIC APPARATUS; L. B. Gray, Boston, Mass. App. filed Feb. 25, 1915. For excluding external noises.

1,177,658. SIGNALING DEVICE FOR AUTOMOBILES AND THE LIKE; E. H. Smith, Jr., Chicago, Ill. App. filed Aug. 1, 1913. Swings into different positions relative to the tail light.

1,177,680. ELECTRIC FURNACE; J. W. Brown, Lakewood, Ohio. App. filed Jan. 8, 1912. Manufacturing of graphite for baking of cokes.

1,177,685. ELECTRIC REGULATION; J. L. Creveling, New York, N. Y. App. filed June 14, 1910. Battery charging system.

1,177,686. ELECTRIC REGULATION; J. L. Creveling, New York, N. Y. App. filed Aug. 21, 1911. Simultaneously adjust for current and voltage fluctuations.

1,177,694. TELEGRAPHIC TYPE PRINTING RECEIVER; A Franke and E. Ehrhardt, Grunewald and Pankow, Germany. App. filed Aug. 19, 1911. Includes a "changing over" device.

1,177,701. INDUCTOR; A. B. Herrick, Cleveland, Ohio. App. filed May 31, 1912. For spark plug. Operated by engine compression.

1,177,702. VARIABLE RESISTOR; J. H. Hodde, Springfield, Ill. App. filed May 3, 1915. Adapted for association with a reversible meter.

1,177,708. WIRELESS SAFETY SHIP SIGNAL; P. Juhasz, South Bend, Ind. App. filed March 1, 1915. Prevents collisions at sea.

1,177,718. ELECTRIC IGNITER; A. C. Merten, Westcliffe, Col. App. filed Feb. 17, 1915. Make and break construction controlled by compression.

1,177,726. ELECTRIC LAPWELDING MACHINE; F. L. Sessions, Lakewood, Ohio. App. filed Aug. 5, 1913. Does away with electrode on the inwardly directed face of the tube-forming sheet.

1,177,753. RAILWAY SIGNAL; J. R. Wilson, Pittsburgh, Pa. App. filed May 20, 1914. Special construction of holding device.

1,177,754. PRINTING TELEGRAPH APPARATUS; W. Zabel, Edgewood Borough, Pa. App. filed April 16, 1914. Translater construction.

1,177,768. RELAY; J. Erickson, Chicago, Ill. App. filed March 3, 1911. Has quick and slow acting contact springs for automatic telephone switches.

1,177,773. RAILWAY TRAFFIC CONTROLLING APPARATUS; C. O. Harrington, Edgewood Borough, Pa. App. filed July 2, 1914. Indicating mechanism for railway switches.

1,177,776. TELEPHONE SYSTEM; C. F. Jones, Oakland, Cal. App. filed Jan. 12, 1915. Designed to supplant "paying" system in hotels.

1,177,778. TELEGRAPH SENDING MACHINE; J. M. Kennedy, St. Louis, Mo. App. filed Dec. 5, 1913. Keys having lateral and vertical movements.

1,177,782. PRINTING TELEGRAPH APPARATUS; L. V. Lewis, Edgewood Borough, Pa. App. filed April 16, 1914. Includes a continuous operating motor with cams.

1,177,788. DYNAMO-ELECTRIC MACHINE; S. H. Martin, Chicago, Ill. App. filed Jan. 2, 1915. Improved field construction and circuits, including concentric annular squirrel cage members.

1,177,789. TRUNKING ARRANGEMENT FOR AUTOMATIC TELEPHONE EXCHANGES; T. G. Martin, Chicago, Ill. App. filed July 23, 1906. Automatic trunking between different exchanges.

1,177,800. VIBRATOR; E. I. Pearson, Leipsic, Ohio. App. filed March 15, 1915. For spark coils. Improved readily adjustable construction.

1,177,819. DISTRIBUTING HEAD; E. O. Schweitzer, Chicago, Ill. App. filed April 5, 1913. Transformer located in hollow pole.

1,177,841. PROTECTING UNIT FOR HIGH-TENSION ELECTRIC SYSTEMS; H. W. Young, Chicago, Ill. App. filed Feb. 28, 1913. Simple, inexpensive construction.

1,177,842. ELECTRIC SIGNALING SYSTEM; S. M. Young, New York, N. Y. App. filed April 25, 1903. Indicates condition of any section of railway.

1,177,867. INSULATOR-PROTECTOR; A. Johnson, North Mankato, Minn. App. filed Nov. 2, 1914. Protective casing surrounding glass insulator.

1,177,881. DYNAMIC CONTROL; W. S. Mayer, Philadelphia, Pa. App. filed May 2, 1912. Particularly for traveling crane motors.

Record of Electrical Patents

Notes on United States Patents issued April 4, 1916, prepared by Mitchell & Allyn, 41 Park Row, New York.

1,177,914. CAR TRUCK; W. S. Adams, Philadelphia, Pa. App. filed June 18, 1915. For light cars.

1,177,920. ELECTRIC CONSTRUCTION; W. C. Brinton, Jr., Manoa, Pa. App. filed Nov. 7, 1914. Joints are enveloped and protected by insulating material.

1,177,923. CAP FOR ELECTRIC CIRCUIT INTERRUPTER; W. H. Brown, Philadelphia, Pa. App. filed July 29, 1915. Hooked lever secures cap to interrupter body.

1,177,924. SPARK PLUG; W. J. Buckley, Bridgeport, Conn. App. filed Sept. 16, 1915. Special electrode construction.

1,177,948. CIRCUIT BREAKER; B. Haskins, Milwaukee, Wis. App. filed Nov. 21, 1910. Impossible to close it during abnormal conditions.

1,177,976. DIMMER FOR AUTOMOBILE HEADLIGHTS; C. J. Wallace, Springfield, Ohio. App. filed Oct. 4, 1913. Resistance coil construction.

1,177,981. MAGNETIC SEPARATOR; P. Wright, Vancouver, British Columbia, Canada. App. filed May 14, 1914. Includes special arrangement of flumes.

1,177,984. CABLE FEEDER; R. W. Beene, Tucson, Ariz. App. filed Sept. 30, 1914. Propells itself through a conduit.

1,177,988. ELECTRICAL RELAY; C. R. H. Buhl, Cleveland, Ohio. App. filed May 4, 1910. Particularly for block signals.

1,177,993. DIVIDED CONDUCTOR FOR ELECTRICAL DISTRIBUTING SYSTEMS; W. H. Cole, Waltham, Mass. App. filed Dec. 3, 1914. Separator insulation of reduced value at predetermined points.

1,177,996. INSULATOR; W. J. Curry and W. A. Andrews, East Liverpool, Ohio. App. filed Jan. 7, 1915. Made in duplicate parts and constructed to prevent wire ever coming into contact with securing nails.

1,177,998. SPARK PLUG; F. Davis, Jr., Duquoin, Ill. App. filed May 4, 1915. Fan-shaped device. Cleans terminals at each stroke of piston.

1,178,021. TELEPHONE; R. H. Manson, Elyria, Ohio. App. filed Oct. 23, 1913. Switch hook protected when apparatus is in use in field.

1,178,023. TELEPHONE KEY; E. G. Mueller, La Grange, Ill. App. filed March 1, 1907. Includes novel catch mechanism.

1,178,029. ELECTRIC CURLING IRON; E. Schwartz, Racine, Wis. App. filed Oct. 22, 1914. Improved pivot construction and heater coils.

1,178,046. SIGNALING APPARATUS; H. B. Anderson and P. Justus, Cleveland, Ohio. App. filed March 9, 1914. Gives indication of extinguishment of tail light or the like.

1,178,057. ELECTRIC HEATER; S. G. Crane, Toledo, Ohio. App. filed Sept. 12, 1914. Water heater arranged to maintain even temperature.

1,178,066. STORAGE BATTERY; W. Gardnier, Chicago, Ill. App. filed Aug. 3, 1914. Avoids all inside connections.

1,178,067. ELECTRICAL IGNITION SYSTEM; E. Gassmann, Brooklyn, N. Y. App. filed Oct. 30, 1915. Improved intensifying of current.

1,178,079. ATTACHMENT FOR ELECTRIC LAMPS; G. M. Laird, Hillsboro, Ill. App. filed Feb. 8, 1915. Attachable to dry cell and made of one continuous strip of metal.

1,178,089. IGNITION DYNAMO; C. T. Mason, Sumter, S. C. App. filed July 28, 1913. Can be made to produce spark when engine is at rest.

1,178,121. CIRCUIT CONTROLLER; J. M. Anderson, Boston, Mass. App. filed Feb. 25, 1914. For end cell switch.

1,178,128. DIRECTION SIGNAL; O. L. Britton, Denver, Col. App. filed April 29, 1915. Motor-operated vane or pointer.

1,178,150. FLEXIBLE CONDUIT FASTENER; M. Guett, Hartford, Conn. App. filed Sept. 26, 1914. For the ends of circular "loom."

1,178,192. SYSTEM OF AUTOMATIC BLOCK-SIGNALLING FOR ELECTRIC RAILWAYS; F. Townsend, deceased, New York, N. Y. App. filed March 5, 1906. Cross-bonds between tracks and protects against rails.

1,178,199. TERMINAL BANK; C. F. Baldwin, GENERATION AND DISTRIBUTION; W. F. Warner, Davenport, Iowa. App. filed Dec. 1, 1913. Internal Combustion engine system.

1,178,199. ELECTRICAL FUSE; J. E. Wood, New York, N. Y. App. filed May 21, 1913. Terminals and fuse elements constitute a unitary structure separable from inclosing casing.

1,178,207. TERMINAL BANK; C. F. Baldwin, Montclair, N. J. App. filed July 6, 1914. Terminals uniformly and properly spaced.

1,178,215. PRINTING TELEGRAPH RECEIVER; G. S. Conger, New York, N. Y. App. filed Oct. 18, 1911. Individual sources of power actuating the different mechanisms. (Fifty-one claims.)

1,178,247. CONTACT FOR SUBSURFACE ELECTRICAL RAILROAD SYSTEMS; O. E. Longsdorf, Chicago, Ill. App. filed Sept. 24, 1915. Energized only on passing of train; avoids arcing.

1,178,267. CONNECTING DEVICE FOR ELECTRICAL CONDUCTORS; G. L. Scheel, Chicago, Ill. App. filed March 17, 1915. Allows free rotary movement of wires connected.

1,178,271. ELECTRIC ALTERNATING-CURRENT MACHINE; C. G. Silvander, Vesteras, Sweden. App. filed March 27, 1913. Mechanical strengthening of bar winding for large machines.

1,178,291. TELEGRAPHY KEY; R. L. Boulter, Los Angeles, Cal. App. filed Aug. 1, 1914. Vibrator adapted to be directly connected to old-style Morse key.

1,178,374. PUSH-BUTTON MECHANISM FOR PASSENGER CARS; C. H. Anderson, Cincinnati, Ohio. App. filed Jan. 21, 1915. Mechanical connections from the push buttons to the current-carrying wires, particularly for steel cars.

1,178,383. INSULATOR; W. H. Caslow, Claridge, Pa. App. filed Aug. 13, 1914. Avoids tie lines and allows for longitudinal movement.

1,178,418. MANUFACTURE OF METALLIC FILAMENTS FOR INCANDESCENT ELECTRIC LAMPS; J. A. Scoular, Hammersmith, London, England. App. filed May 28, 1914. Immerses baked tungsten filaments in hydrofloric acid solution.

1,178,424. SPARK PLUG; J. A. Soden, Toledo, Ohio. App. filed June 23, 1915. Accidental displacement of power electrodes is prevented.

1,178,430. PROCESS OF ELECTRICAL SEPARATION; H. A. Wentworth, Lynn, Mass. App. filed Dec. 21, 1907. Material passed through electrolytic field in contact with an electrode surface.

1,178,431. INTERMITTENT CURRENT CONVEYOR; J. H. Wheelock, Worcester, Mass. App. filed May 27, 1914. For call systems, chargeable signs, etc.—open circuit.

1,178,432. INTERMITTENT CURRENT CONVEYOR FOR CLOSED CIRCUITS; J. H. Wheelock, Worcester, Mass. App. filed Nov. 3, 1915. Closed-circuit system.

1,178,454. IGNITION DYNAMO; C. T. Mason, Sumter, S. C. App. filed Feb. 14, 1913. Advancement or retardment accomplished by movable cold shoes.

1,178,455. DYNAMO ELECTRIC MACHINE; A. H. Neuland, San Francisco, Cal. App. filed July 11, 1914. Generates direct-current or single-phase or poly-phase alternating current.

1,178,467. WHISTLE OPERATING MECHANISM; E. W. Bullard, Springfield, Mass. App. filed Oct. 1, 1912. Magnet for operating exhaust horn.

1,178,471. AUTOMATIC TELEPHONE EXCHANGE APPARATUS; G. E. Kimball, Chicago, Ill. App. filed Nov. 24, 1906. Improved automatic step-by-step operation.

1,178,472. TELEPHONE TRANSMISSION SYSTEM; A. B. Smith, Evanston, Ill. App. filed June 9, 1913. For transmitting music.

1,178,479. ELECTRIC LAMP SOCKET; W. H. Elliott, Austin, Tex. App. filed April 27, 1915. "Three-way" switch construction.

1,175,417. ELECTRIC METER AND FLUID GAGE; A. K. O. and R. Fehrenbach, Woodbury, N. J. App. filed May 15, 1915. Voltmeter or ameter which also may indicate liquid in tanks.